THE SURVEYOR, ENGINEER, AND ARCHITECT;

OR,

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IN ALL THEIR DEPARTMENTS.

BY A COMMITTEE OF PRACTICAL SURVEYORS, ENGINEERS, AND ARCHITECTS, OF MUCH EXPERIENCE AND IN ACTIVE EMPLOYMENT

ROBERT MUDIE, LITERARY CONDUCTOR.

THE ORDNANCE SURVEY.

SIR,

As the following letter is not so much a personal address to Colonel Coby, as a hint of what should be the objects of his labours and those of his assistants, I address it to you.

TO COLONEL COBY AND THE OTHER GENTLEMEN ENGAGED ON THE NEW SURVEY OF ENGLAND, UNDER THE BOARD OF ORDNANCE.

GENTLEMEN,

If I am rightly informed, the new survey of England, on which you are now engaged, is to be mapped on a scale of five inches to the mile, which will give ample breadth for all the topographical details, and also for many particulars of a very important nature, which are not contained in the maps representing the former survey. You will therefore have the kindness to excuse me if I offer some remarks on the nature and uses of these details.

The survey from which the published maps were drawn was no doubt as accurate and faithful, so far as it went, as the ablest men and the best instruments could render it; and, except in the enlarged scale and the alterations in the topographical details, with a clearer view of the features of the surface, no very great improvement can be made upon it, in as far as it goes. It is true that the survey of Ireland is superior to that of Britain, owing partly to the larger scale, partly to some improved instruments and improvements in the use of them, and partly, perhaps in greater part, to the surface of Ireland, which is remarkably well adapted for an accurate survey. The centre of Ireland, including great part of the surface, is not very much elevated, nor does it deviate greatly from one continuous plane, except in the transverse ridges of mountains, which extend from Wicklow south-westward into the adjoining counties. On this account, the mountains, which in many parts form a boundary as it were to Ireland, are seen from each other at long distances, and, therefore, the lines of ramification which compose the principal triangles are almost all commanded by a single sight. This a great advantage to the surveyor; but it is one which England does not possess. In that country the principal chains are central; and even where a considerable breadth of surface is comparatively flat, there are transverse heights or spires which break the view; and thus a long line cannot be obtained without a succession of sights, and as the number of these is increased, so is the chance, nay, almost the necessity, of error. These disadvantages, with the resulting errors, are inseparable from the very nature of England; and, therefore, the truth of the positions cannot be approximated with the same accuracy as in Ireland, though I have no doubt that both in the previous survey and the present one the utmost care has been taken, and will be taken, to reduce them to as small an amount as possible.

But, granting that a map upon the same plan, that is containing the same materials and information, as the published ordnance map, could be constructed so as to be accurate to the smallest fraction of an inch in every part, it would not afford that information which a government map ought to afford. It would still be merely a topographical map, the same as those which are published every day by any body, with only this difference, that it would be more correct in its positions, and more full in its details. One improvement is, no doubt, in the progress of being introduced into the published map. in the delineation of the geological features by Mr. T. De la Beche, a gentleman every way well qualified for the task: but these delineations are not part of the general impression; and the geologist must all along continue much in rear of the engineer, whereas he ought to be a fellow labourer with the original surveyor and draughtsman. It is true that, in the earlier parts of the work, this could not have been the case, because at that time geology was a subject of wrangling and disputation, and had not acquired the consistency and the dignity of a science; and though it had, and the different formations had been delineated with the greatest accuracy, that would merely have supplied one, and far from the most important one, of the desiderata for which one looks in vain in the ordnance map. The geological structure, together with the many qualities of surface, as delineated by the engraver, do not afford an idea at all adequate to a right understanding of the country; and I am compelled to say of the engraving of the features in the ordnance map, that they are far more laboured than graphic; and thus they give no adequate idea of the relative heights of different places.

As there are no data for the geological adaptations contained in the engraved map, and as the memorials of positions are comparatively few, the geology requires either a new supplemental survey, or much to be done by mere hazard. This is expensive, or incorrect, or both, in the matter of mere geology; and, supposing it to be well done, it is only a small portion of what the map should afford, but does not. Taking the map as it was engraved, though it is superior to the common maps in its positions and topographical details, it is actually inferior to them for some purposes, and among them those of the general reader. He does not want perfect exactness of positions, and the marking of all the towns, villages, hamlets, gentlemen's seats, churches, and other matters of detail: he wishes to have a tolerably correct general idea of the shape and natural situations of the principal parts of the country; and this can be best obtained from a map which the eye can command at one view. If the ordnance map were completed, there are few apartments in the country, and those only public rooms, in which it could be put together and displayed as a single map; and this circumstance alone points out that, as its size is peculiar, so also must be its principal use. It is a map to be examined in sections only, unless it is put up in a great hall, and viewed by means of a telescope. Then, as the map from the new survey is to be on a scale five times greater in line, or twenty-five times greater in sur-

face, there is no room in Britain, or indeed in any other country, in which it could be exhibited as a whole; therefore, all of the inconveniences in the first ordnance map will be increased five-and-twenty-fold in the new one, if the scale is to be what has been stated. It follows, as a matter of course, that the proper subjects of a government map should be increased in an equal ratio. The map of some single counties will be too extensive for being displayed in any thing but the very largest apartments, and, therefore, even this will not be available at a single view; for if the eye is brought to the position at which it will see the details in the centre, those on the confines will, in consequence of the obliquity of the light, be obscured, and, in the larger counties, obliterated to ordinary vision. It will thus be reduced to a sectional map, of which a small portion only will be visible at one glance; and this again demands the greatest fulness of the information which such a map ought to contain. It is to be borne in mind that England is an insular country, of which the shores are deeply indented by bays, wide estuaries, and the mouths of navigable rivers, all of which are available for foreign navigation, or that still more important sailing or steaming along the coast, and in the bays and mouths of the rivers, which brings the different parts of the country much nearer to each other for travelling and for trade, than they would be without this navigation. The waters which wash the coasts of the country, whether on the shores of seas, or on the banks of inland waters, are therefore general points that require to be set forth in a government map; but of what should be shown concerning them I shall treat at a little more length in a subsequent part of this paper, only premising in the mean time, that the action and motions of the water, and the influence of the prevailing winds, and the discharges of rivers upon these, should be delineated on the map, or, if this be impracticable, explained in a printed memoir, to be had recourse to as a book of reference.

The second general point, and by far the more important one, however, is the information which the map should afford respecting the land; and this can be much more clearly rendered by pictorial expression than that which concerns the sea. I have supposed that the topography is as faithfully and clearly done as possible, both with respect to natural features, and to works and erections by man; and I have farther supposed that the geological strata, both those in which mines are situated, and those whose decomposition forms the leading healthy ingredient of the soil, are represented with equal force and truth; but it remains to be considered what the map should show in addition to these; and the preliminary question is, What is the object, or what are the objects? The answer to this is, that the map may point out practical improvements, both agricultural and commercial; the agricultural ones being such as relate to improving the soil, and thereby increasing the production of the land; and the commercial ones to improved lines of communication between one place and another. The commercial improvements have been much more attended to than the agricultural ones; and what with carriage-roads, railroads, and canals, there remains not much to be done in the way of internal communication, although whether the doing is the best that could have been done is a very different matter. One can observe that, not the execution merely, but the engineering of the common roads is, in a great many instances, very bad; it is bad as respects the situation and laying down of the lines, and no better in the way in which the workmen have been directed to execute them. For the bad positions of the existing common roads, road engineers of the present day, or of times very recent, are not to be blamed; all the very old ones are laid down upon old foot-paths, and ways for pack-horses, which had existed, and to a considerable extent determined the situation of the villages and populous places, before there was one good line of road in the country except the common roads; and these being laid down wholly or chiefly as lines of transport, without any reference to the populous places, they do not in general answer well for the modern state of the country, according to which all places along the line, or in the district across which it passes, require their share of the benefit. In the making of new portions of the line, or what is styled improving the state of the old one, matters are very often not made better. There are local interests which so break in upon the improvement as to make it in reality no improvement at all. One proprietor, for example, who is a trustee upon the local portion of the road, twists it to the right or left, to prevent it from cutting off a small corner of his park or grounds; and another sends it up the steep upon one side the rise, and down the slope on the other, in order that it may pass an ale-house on the top which is his property, and depends mainly on the road for the means of paying him his rack-rent, which he is sure to demand and get, as he has the power of granting or withdrawing the license. To accommodate itself to these local interests, the road is twisted right and left, and up and down, like a corkscrew, whereby its length is increased, and so is the traction of carriages upon it.

Why this should be the case is rather a puzzle to those are unacquainted with the state of local administration in England; but when that is once known, the puzzle is at an end. The management of the road is in the hands of a little nest of local trustees, who turn it to their own interest by making it suit their own purposes in the position of the line, and also in the appointment of their own creatures to surveyorships and other offices of trust. I have known of a case where a few miles of road made a tolerable sort of little freehold to a person who had no other claim than that of having married a woman formerly in keeping by an influential trustee, nor is there any doubt that appointments of this, or of similar kinds, are far from being unfrequent. Thus, whether the lines are good or no, they are always costly enough to the public. The grand reason why this is allowed to be done, is the cutting of the road into a number of short lengths, each under the controul of its own trustee, and quite independent both of the government and of the public; whereas, if government had the general management, the road would be far better, and the expense of keeping it much below half of what it is now. But, granting that the trusteeships were abolished, and government authority, as it ought to be, substituted in their place; and granting also that the turnpike gates were all removed, and the expense of making and keeping the road were a charge upon the general revenue of the country, there would still be wanting, for the perfection of the roads, some well-established data for ascertaining the best line possible. This information ought to be shown by the government map; but as it affects some other matters for improvement, it will be better considered by and by.

The badness of the materials and making of the roads, is owing partly to the indifference of the trustees, and partly to the ignorance of the road makers. We do not say that bad materials are, in all cases, preferred to good, even though the getting the former exceeds in expense the advantage of the latter; but the case is, or possibly was, too frequent. Considerable improvement had taken place

before the making of the railways; but I believe that, since these diminished the funds, the state of things has again become worse. I do not say that any matter inserted in a map of the country would remove the bad legislation, or correct the errors in the lines; but if the map contained an easy and obvious method of finding the best line, that would go at least some distance in shaming the parties concerned out of the worse one. Simple and silently setting before mankind an evil of which they are guilty, is sometimes more successful in bringing them back to the right than all the remonstrance and argument which could be employed on the occasion.

In the case of railways, it is probable that more evil arose from want of information in the map, than in the lines of common carriage road. Every tyro in the profession knows, that though any two proposed lines between two points can be compared with each other, and the better of them found by the comparison, yet that there are no data for ascertaining whether there may not be a better line than either of these two, in respect both of the height of the summit level, and of the quality of the matter which had to be cut through in forming the lines, which is a grand point in making of railways, both as to lessening the chance of accidents, and to diminishing the expense of keeping the line in a state of repair. For a badly laid down line of railway, there is no such excuse as the plea of antiquity, and the tying down of the parties by custom, either voluntary or of necessity. Railway lines are determined by enactments of the House of Commons: and thus the railway has a chance of being better than if it were trammeled by ancient law and local interest.

But, wherever there is any chance of levying money upon the public by the projectors, or of their endeavouring to procure a site for the line, as cheaply as possible, the parties are always in danger of injuring themselves upon this tack; and perhaps there is no line of any considerable length upon which this has not, to a considerable extent, been the case. Nay, there have been errors in laying down the levels of the more extensive railways, even in cases where they wished to be correct; and the distance of buildings from the vicinity, and the chance of making errors with regard to the materials, are difficult to avoid; but a judiciously chosen line would, at least, assist in preventing them. Canals are not subject to so great chances of error in the construction, because, in making them, both the level of the line and the nature of the ground have to be taken into account.

The position of lines of communication, though not an unimportant matter, is much inferior in importance to the fertility and produce of the land itself; and, therefore, the improvement of the land is a first-rate matter; and, fortunately, it is one upon which the map might throw more light than it can upon most others. The result aimed at, is the produce of the land, and its increase, both in quality and quantity; and, important as are some products of manufacture, such as that of cotton, they do not nearly come up to the produce of the soil. This, also, is a subject upon which more good can be done by well-applied improvements than can be done by any other. When we speak of the value of this product, and consequently of the kind of labour by which it may be increased, we speak of something that is not only of paramount value at the time, but also of one whereof the value is much more permanent. Every branch of commercial industry fluctuates with the fashions of society, some quickly, and others at longer periods; but whatever the length of the period, fluctation is inseparable from their very nature. The product of the soil and its increase do not partake of this fluctuating nature; they are permanent, and they are so because the nature of the subjects which result is durable, and safe against fluctuation and change; for the majority of men may give up the use of one product for that of another. Sometimes one manufactured article is in fashion, and sometimes another; some persons may change the fashion; but, in spite of all the changes which it is continually undergoing, everybody must eat, regardless of what may be fashionable.

The grand improvement, data for which can be represented in a map, and which is in fact the most important of what, on the great scale, land is susceptible, is the proper distribution of water over its surface; and, in order to accomplish this with ease and certainty, the position and inclination of the slopes must be known. This is the information which the map should afford, in addition to its position, its topography, and geology, and beyond this it can barely be carried. Upon the same slope, water is in abundance in one place, and deficient in another. Where the abundance is too great, it stagnates, and converts the soil into a marsh, unfit for the plough, destructive to sheep, and not profitable for any kind of stock, as the grass upon it is rank and coarse, and contains little nourishment in proportion to its quantity. Then, again, where moisture is deficient, and runs off without producing due effect, the ground, especially if it has a southern or south-western exposure, is sterile, owing to the alternate scourging of the rain, and parching of the sun. On such surfaces, the crop ripens well, but is sadly deficient in quantity, and the grass, though wholesome enough, is hard and wiry; a great breadth of land is necessary for the subsistence of a scanty stock of the lighter kind, and quite unfit for fatting an animal to any decent marketable weight. The cure of this consists in drainage for the marsh, and irrigation, or the trickling of water over it, for the parched soil; and, wherever these can be both accomplished, the whole slope is rendered wholesome and productive, whether it be under tillage, or laid down in pasture.

For the accomplishment of this by a reasonable degree of art and labour, nature herself makes provision. More rain always falls on the high ground than on the low, and all that requires to be done is to retain it in proper dams or tanks, from which it can be given out as necessity requires. Even where the water cannot be directly employed in irrigating the dry and upland part of the slope, as is the case when it descends in deep-channelled rills from the *plateau*, or extent of level surface, it is still useful to retain it there in tanks and reservoirs, because, though water thus retained cannot be so extensively employed in irrigation, as water otherwise disposed, the tanks and ponds form atmospherical moisture and dew, which refresh the plants on the dry height, and greatly add to their fertility; and, if this retained moisture is duly interspersed with artificial plantations, which break the course of the winds, and also retain a moistness in the atmosphere, the fertility may be increased to a greater degree than those who have not seen it would readily believe. But though this mode of treating the uplands is very rare compared with what it ought to be, there are enough of practical examples in the country to establish its truth. Two hills shall be found in juxta-position with each other, of the same elevation, the same geological structure, and the same form of slopes; but between them there shall be this difference, that the one is dry and bare, and the other abounding in artificial collections of water, interspersed with such coppices as grow on high ground; and in consequence of this circumstance the latter shall seem an Eden, and

the former a wilderness. The water, too, can in general be successfully drained from the marshy ground. This ground is rarely in the very bottom, unless where the river has been neglected, and there are few such neglects that do not admit of considerable amelioration, if not of perfect cure. The marshes are in the hollows or levels higher than the bed of the general stream, and not unfrequently at or near the very summit; and in such situations they admit of ready drainage, though that drainage cannot be shown in the map; being indeed an application of the principle, and not that principle itself, it cannot be shown in the map or described here with anything like propriety. While treating of this part of the subject, it may, however, be mentioned, that every slope and valley must depend for its humidity upon the rain which falls within the boundaries of its own summit level; for, excepting what is taken up by evaporation, and borne on the winds from the humid and, therefore, cold surface, to the warm and, therefore, dry one, there is no transfer of water from valley to valley; and this is the reason why some valleys are humid, and prone to the formation of marsh in the lower parts, and peat-bog in the upper, while others are parched in the upper part, and fertile soil and kindly vegetation in the lower. This takes place with little difference of temperature, except such as arises from the greater evaporation on the humid soils, which evaporation lowers the summer temperature, but equalizes that of the whole year, so that such places are the best adapted for pasturage, while those of the opposite character suit better for tillage; and, in consequence of this, the eastern side of Britain, especially a little northward of the Channel, is the corn side of the country, while the western is the grazing one; but, as applied to highly-bred stock, the difference does not hold good. But these are topographical applications of the principle, and not the principle itself, as it can be shown in a map. Upon that, altitudes are the only data, in addition to the positions and the geological structure, which can be shown, and they answer as points of reference for all that has been stated, and a good deal more.

The portion of the map which shows this is called a *terrière* by the French, and has been partially introduced into their national maps, in which it is proved to be of the greatest service. To form a proper idea of a *terrière*, let lines be drawn along the summit levels which bound the several valleys, and also across the valleys in every situation in which they are wanted. Let as many points be taken in those lines as may be thought necessary, and the elevation of each point above the level of the sea be marked at each point of the lines, and also at every important place which lies intermediate or adjacent, and the *terrière* is complete. Care must be had, however, that the points are properly situated, and the elevations rightly marked above the sea, at the same place, in the same kind of weather, and state of the tide, otherwise the points of reference, and whatever is founded upon them, will be incorrect. The distances of the points from each other may be found by the common observations of the survey, but the ascertaining of the heights is a little more difficult. As there are circulating tide waves around Britain, which are subject to fluctuations, the elevations must be taken from some point which is the lowest that can be observed; and all the rest must be made out by levelling from this one, which is rather a nice business, as the angles of elevation are always very small, and the differences often next to nothing.

Such are the directions which should be followed in obtaining data for the new map; and if they are accurately represented, and the map itself correct, nothing more is wanted to render it a most useful document.

AN OLD SURVEYOR.

NAVIGABLE ESTUARIES, &c.;

THEIR USEFULNESS, PRESERVATION, AND IMPROVEMENT.

THIS is a subject to which Surveyors, Engineers, and those Architects whose principal employment it is to execute building-works pointed out by the Engineer, should be chiefly, assiduously, and vigorously directed. At all times, this subject demands great attention; but the urgency of it is more pressing just now, than perhaps it ever was at a former period. The railways, which came upon speculators and the public generally like an overwhelming flood, and in too many instances carried them away, or, which is the same thing, carried away their senses, and their fortunes followed to a large amount—this extraordinary drawing of the wonderment and wits of an unprecedented number of the people toward one subject, in utter neglect of many other subjects of equal importance, cast a sort of *glamour* over the eyes of Engineers, and they saw, or in the paroxysm of their distempered vision thought they saw, a perfect *El Dorado*, in which gold might be gotten in countless heaps, and for innumerable ages, from the planning of lines of railways. This was no doubt a sheer delusion, one of those mental visions which, like the pestilence, walk the earth, but, unlike that, do not walk it in secret; but still it produced the same effect as though it had been a reality, established by mathematical demonstration to the mind, and by physical demonstration to the senses. While the hot fit was upon them—

> "For 'twas an ague quite reversed,
> Whose hot fit seized the patient first,"

they would not be made to believe that ever the country could have enough of railways, or that it was possible so to construct a railway as to make it an interminable nuisance to the proprietors in respect of expense, and a subject of perpetual alarm and danger, and very often a most serious calamity, to the public. Hence bills passed into the House of Commons as thick as locusts, to eat up the country; men who had no single recommendation but sheer impudence, made their way from hovels to palaces; and everybody who could swear roundly enough as to the necessity, practicability, and value of one of these works, was instantly dubbed a Railway Engineer; and the less he knew about the true nature and conducting of such works, the better he was adapted for being a tool in the hands of the jobbers. The usual methods of notoriety were not deemed sufficient for speeding on the humbug and trickery so rapidly as was desired, and hence newspapers, bred out of the subject as maggots are out of carrion, speedily buzzed about, sporting their wings, and drumming with their coxæ, to extend the love and the laudation of that in which they had been fostered. In plain English, the hallucination which had come over the public brought forth a swarm of incompetent engineers, who planned works to be—speedily destroyed.

But, in all cases of this kind, whether the hot fit or the cold takes the lead, the whole turns round, and the two are always so equalised, that the average is brought to nearly the same in every case. There

is only this difference,—that the time and fatigue and pain of getting from the one fit to the average state or the opposite fit, are always in proportion to the violence of the fit itself. This is the case with most, if not all, of those who ruin themselves at the gaming-table. They go thither, not from any disposition to squander, but, on the contrary, from having more cupidity and avarice than prudent men have; and they continue lingering about the table after they are ruined, in the hope of some chance turning up which shall enable them to regain all they have lost, and more to boot. This has been the case with the greater number of those engineers who have dabbled in railway-making. They have entered enthusiastically into the matter, in proportion as they were ignorant and inexperienced; and, except "a few knowing old gamesters," they are now, or will soon be, in the condition of men ruined at play.

In illustration, take such of the engineers as have had the good luck—for it is only a matter of luck—"to make themselves friends of the mammon of unrighteousness," and convert what ought to have been a temporary job into a life-rent holding, by insuring a per-centage, year after year, upon the cost of those mischances which are the result of their own blunders, or rather of those of the contractors and other working people under them. This last is the view which an Engineer takes of the matter, where he merely plans, and the contractors execute; but, though this affords a loop-hole through which a whole drove of engineers might bolt off in an instant, *per saltum*, and scratch-free of all blame from their employers, it is not exactly the correct view of the case; for, in equity, the engineer is just as responsible for the proper execution of work by contractors under him, as he would be were he to execute the work by his own men, or even with his own hands.

We must not blame the Engineers for the blunders which have been committed in the great majority of those railways, for the work came upon them when they were unprepared for it. We said on a former occasion, and we now repeat, that Engineers cannot be grown like mushrooms; and that, therefore, if an undue pressure come upon engineering, those who employ engineers must lay their account with having it badly done. This is the grand fault which has been committed; and this fault is in no wise chargeable against the Engineers, nor does it furnish any proof of want of talent on the part of those by whom these blunders are made. If men are expected to do any given work, and do it well, they must be well prepared for the doing of it; and if the public will not wait for due preparation on the part of those whom they call upon to work, the blame is in the public, and not in the professional men, thus unjustly called upon to work before they are prepared. That it would be easy to select the worst, where all or the greater part is bad, is unquestionably true; but in such a case there is no best or better to choose upon; and to expect that when a mushroom crop of railways spring up in the country, a mushroom crop of engineers should spring up simultaneously with the demand, is perfectly absurd. Yet this is what is required at the hands of the engineers of the present time, or rather, what was required of them some little time ago; and as far as there has been fault in the matter, that fault has been clearly owing to the stock-jobbers and others by whom the unnatural demand has been created, though the Engineers have got the blame of it.

This is a correct view of the case; but it is one which the projectors of these works will not take, inasmuch as it charges the blame against themselves: this is also what is naturally done by the public. These see the railway as connected with the engineers, but they do not see it as connected with the projectors, or whoever else are the parties really to blame. The consequence is, that the engineers are they who come in for the whole blame; and there is not a slip of an embankment, or any other casualty, which is not chargeable to them.

It sometimes happens that one or more engineers have more ability and experience than the rest; and because of this it is said that, by undue preference, such parties are enabled to make ample fortunes by those speculations.

Besides these medium and mighty good fortunes in the engineering craft, there is much, or rather there are many, to whom it chances very differently. The fortunates are, like Oases in the Lybian desert, small, few, and far between, all the rest being waste and dreary wilderness, and it is this wilderness which calls into action both our pity and our pen. Railways, upon the grand scale, are at an end; and, though a few of the engineers have wandered into foreign parts, and got into temporary employment there, they have only taught the profession to foreigners; and their employment must, in consequence of this, be very temporary. Therefore, we have engineers by scores and by hundreds, made or making, for whom, in the present state of things, there is no occupation; for, besides the fact that all the great lines of tempest-speed thoroughfare along the land are made, the cash has been so drained by the making of these, that the youngest engineer will be hoary before a paroxysm can come round, in which the public shall say Amen to anybody who calls himself an Engineer, and pay him handsomely for his boldness and spirit, in giving himself a name far higher than he deserves.

But, notwithstanding all this, an Engineer, even a nominal one, always costs the country something; and therefore they should not be left either to "wander to and fro on the earth, or delve up and down through it," like the arch-engineer in the days of Job; or stand blubbering over their broken pitchers, like silly girls who have met with an accident at the fountain. Something is wanted for them to do—something, in the doing of which they may be useful both to themselves and their country; and this something is wanted in no stinted measure, and for no brief continuance.

Now, the question is, What shall be got that will serve the country, and remunerate those engineers who, as matters stand at present, have their faces toward the ends of the earth, or toward the workhouse? On land there is nothing for them, unless they were to obliterate the present lines of railway, and make new and better ones in their stead; and for this there is no money to spare, nor any necessity so urgent as to make the nation beggar itself outright. We have hinted, that those engineers should be kept at home, because, whatever may be their merits and value, the exportation of them would be bad. We have already paid rather too much for sending the industrious out of the country, in the hope of thereby benefiting the idle; for the labours of our machinists and other tradesmen, and the application of those tools which they carried with them, are now telling with treble retribution in all our manufacturing towns, and their example has so schooled foreigners in those arts which are properly ours, that we are sinking down in the scale of operative nations every day, without the slightest means of rendering ourselves more buoyant.

The proper lesson to be drawn from this is, that we must find British employment for British engineers, until the revolution of the wheel of time shall withdraw the supernumeraries into other

courses. But, as we have said, occupation on the land there is none, adequate to the full and proper employment of even a reasonable portion of the number which actually exists, and is becoming daily more craving for something on which to be employed.

This brings us immediately to the question, What are they to do? This we answer first and briefly by an analogy,—What does water do when it has ceased to be useful on the land, or in the air? It runs seaward, and finds place and occupation there, until, in the course of nature, it is again called back by the process of evaporation. Much the same as this should be the present views, and for a time, at least, the future occupation of our engineers. In a social point of view, we are in some measure an amphibious people; we live *on* the land, but we live *by* both the land and the sea, and therefore the balance of accommodation between these should be kept up. This was pretty much the case previous to the construction of the railways, and the employment of steam trains upon them for land travelling and carriage. Indeed, we are rather inclined to think, that, from the introduction of steam-boats, to the opening of those railways, the sea, or at all events the narrow portions of it which indent our shores, had the advantage. Now, however, the advantage of transit is clearly and considerably on the part of the land, and we want to have the water engineered up to something like a balance.

To enter into any general statement of the benefits which Britain derives from the sea, would be quite unnecessary; for, both on the great scale and on the small, they are seen at a glance, and have been felt by practical experience for a great number of years. Spread out the map of the world; examine well the different lands which are delineated upon it; and fix upon a spot which has anything like half the advantages of Britain, in a marine point of view. It commands, by the most free and ready pathway that the waters can afford, an intercourse with every maritime place on the globe; and the consequences are, that British keels divide the waters of every portion of the sea; the products of all lands are as abundant in Britain as if they were native, and every people under the canopy of heaven may, if they will, enjoy the benefits of British capital, skill, and industry, as abundantly, and on as favourable terms, as if the commodity with which Britain supplies them were all of their own home manufacture.

This, however, is not the portion of British connection with the sea, and by means of the sea with all lands, to which the attention of engineers should or can be directed. The mighty mass of the ocean waters defies all human control, excepting in so far as ships may traverse it by the aid of those winds which sweep along its surface, or by engines which impel the vessel on its course, despite the strength and direct opposition of ordinary states of the atmosphere, whether in motion or at rest. The steam ship is not subject to be driven far from its course by adverse winds, nor can it be becalmed in the most motionless state of the atmosphere. Therefore, though the sailing vessel has its advantages, the steam ship has its advantages too, and those in circumstances in which the sailing vessel is most at a loss.

But, further than in the construction of the vessel, the mode of conducting it, and the finding of its place or situation with certainty whenever that is required, the utmost science and skill and practical dexterity of man can have no control over the deep. He cannot command the tide to roll back its wave, or the wind to be still, but must leave them to the control of a higher power. As little can he order the rock to get out of his way, or the bank to be removed to another place. He must take the sea just as he finds it, and adapt his art to it in the best way that he can, without any yielding or accommodation on its part.

There is, however, something intermediate between the wide sea and the solid land, to which the skill of the engineer can be applied with equal success and advantage. This is, the general line of separation or of union between the shores of the sea and the coast of the land. We call it the "shore," because along it the land as it were supports, or "shores up" the water; and we call it the "coast," because it defends the land from external action, just as the ribs are a defence to the most important viscera of an animal.

Without any regard to the nature and size of the craft, or the length of the voyages which they perform, there are two sections or kinds of intercourse, that is, of arriving at the boundary line between the one and the other. There may be harbours, or places for arrival and departure, on the main lines of coast, and there may be the same upon those of bays, estuaries, embouchures of rivers, creeks, and other indentations which stretch from the sea inward to greater distances in the land, and are navigable. When these are of larger dimensions, and especially when they are of considerable breadth, they are almost as completely without the province of the engineer as the wide sea itself; but when they narrow to within moderate dimensions, varying with the quantity of fresh or river water, and other circumstances, the Engineer has more or less control over them, and this control, duly exercised, is one of the most valuable of his multiform operations. Before, however, we even hint, which is all we shall find room to do in the present paper, at any one of these operations, we must say a few words on the general advantages of such places, accompanying these with a passing glance at the irregularities of the British coast.

Compared with navigation to and from open shores, that of estuaries and inlets has many advantages. If a bay has a moderate entrance, and is sheltered from the prevailing winds by high grounds, it is a haven of safety as compared with one of the most accessible coasts. So also an estuary, if the opening to it is tolerably wide, has many advantages. It is more easily made in adverse winds or stormy weather than a coast harbour; and if it penetrates far into the land, the upper part of it is comparatively free from the injury of storms. In most long estuaries too, there are lateral creeks, and the embouchures of secondary rivers, which afford shelter from danger, and also accommodate a minor species of navigation. The grand importance of long estuaries consists, however, in carrying the navigation into the interior of the country: this operates in many ways. The whole district through which the estuary passes has the advantage of being accessible to shipping; the upper part of such an estuary especially is generally very rich ground, and forms, as well from this, as from its being nearly surrounded by land, the very best site for a large town; and if the country is not broad, and such estuaries are numerous, they not only form bands of communication among all the people of the different districts, but they give facility for an exchange of the produce, whether natural or manufactured, of all the parts, and the most convenient emporium to which it may be collected for home use and for export, or from which the imports of foreign climes may be most easily and cheaply distributed all over the country. Turn to the map of Britain, examine the situation of London, of Bristol, of Liverpool, of Glasgow, and see how much their advantage would be curtailed if they were situated upon the open shore. Each would then command only half a

country, whereas, by being on the estuaries, they have one all round, except at the external entrance. This maritime part is generally rich and fertile, and on this account the inhabitants have a much greater and more accessible supply of local produce. This is a very important matter, because a large town cannot exist, far less carry on extensive works, without a corresponding supply of rovisions. London is a grand instance of this; fresh provisions are speedily and abundantly brought to it from all the surrounding country; and the river affords cheap carriage for a considerable distance seaward. Thus, independently of what is imported from abroad, or brought from more distant parts of the home country, London receives immense local supplies, which are reciprocally advantageous to it and to the places whence they are brought; so that, if a circle of some twenty miles radius, but differing with the nature of the soil, were drawn around St. Paul's as centre, if would be found that the produce of the land, acre for acre, would be two or three times greater on the average; and ten, and even twenty times greater in the most advantageous spots, than if London did nor exist. Indeed, were it not for this abundant supply of imported, and especially of local produce, London could never find provisions for its million and a half of inhabitants, even on the most penurious and stinted scale, far less in that abundance and for those easy prices which we see at present. Therefore, one great object of the Engineer ought to be, to open the best possible lines of communication converging upon the estuarial emporium from all parts. Of these, however, the estuary itself is always by far the best; and, therefore, the grand and imperative duty of the Engineer is to keep it as free from interruptions and hazards as possible. Under what circumstances this can or cannot be done, is a question of the topography of each particular river, and must be worked out upon the data derived from actual survey and personal experience of that river, and therefore can form no part of a general description. This, however, does not lessen the necessity of studying it, but rather the reverse, because more knowledge must be had and acted upon than if one general system applied equally to all estuaries.

Turn again to the map of Britain, and compare its outlines with those of Europe, any part of Europe, or any other portion of the land, whether continental or insular, and you will perceive at a single glance that, in the number of estuaries, and the distance to which they pervade the country in proportion to its breadth, Britain is far superior to every other portion of the land; so superior indeed that, instead of being a maritime country only along the coasts, it is maritime almost to the very centre, for, if the estuaries are examined, it will be found that, at comparative short distances, Britain derives the same advantages from the sea as if its breadth were reduced one half, and this independently of the value of the coast of the estuaries themselves, which, mile for mile, are always greater than those of the open sea.

In casting a hasty glance at them, we shall not notice the smaller creeks and entrances of the minor rivers, but pass them over with the general remark, that they are all, speaking on the average, valuable in proportion to their extent. Of the larger estuaries, there is a sufficient number to establish the truth of our position, and therefore we shall confine ourselves to these. In speaking of them we shall enter into no measurements or other matters of detail, because we shall have occasion to advert to these in future papers, embodying information communicated by those who are resident on the spot, and have personal experience of what they communicate.

Look, then, at the map, and you will find that the entire length of the country approximates to the connection of a chain of islands, the boundaries of which are more or less definitely marked, according to the extent and character of the estuaries. First, on the eastern side there is the estuary of the Thames, penetrating a long way inward into the country; and, first on the western coast, there is the Bristol Channel, which is the estuary of several rivers, whereof the Severn is by far the most considerable. London, the emporium of the Thames, is situated near, indeed, we may say, at the top of the tide-way, and the action of the water in the river gradually becomes more and more moderate as this point is approached. It is true that there are greater hazards in the navigation of the upper part of the Thames than in almost any other of the estuaries. These, however, are not natural, but occasioned by navigation itself. Bristol, the emporium of the western estuary, is not at the top of the tide-way, for the tidal wave rolls in with great violence there; it is further down, and on the banks of the Avon, which is a supplemental and inferior river. From this situation Bristol commands only the one side of the country without crossing the channel, and in this respect its situation is less advantageous than that of London. Still the country around Bristol is rich and valu- and able; thus, though Bath is at no great distance, the situation of Bristol is a good one.

Turning again to the eastern side of the country, we find numerous entrances and small openings between the Thames and the Wash; but there is not one, taken singly, of any very decided character, until we come to the Humber, between Lincoln and York. This estuary receives many rivers, and the conflict of their waters, and also of the whole with the sea, especially the eddy from the southward, occasions the deposition of a number of mud banks on various parts of the Humber, so that it is not very advantageous for the situation of a great emporium. Hull, or Kingston on the river Hull, is at present the largest town on the Humber, but Goole, farther up, and near the great manufacturing district of West York, is fast gaining upon it. This is the part of England where the absence of a good maritime emporium is most conspicuous; for much of the land in the immediate neighbourhood is exceedingly rich; and the country at a very little distance westward is full of manufactories, and abounds in coal. Opposite the Humber, and with it forming the second natural section of the country, there is the the Mersey, a well-defined estuary, but not of any great length, or very convenient for the purposes of navigation. Still, Liverpool, situated upon it, is the second port in the kingdom, the emporium of the great manufactories of Lancashire and the surrounding districts, and a place of great trade with all parts of the world. For the three kingdoms which compose the home dominions of Britain, it is more central than any other place, being well situated for intercourse with a large extent of England, and also with Dublin and Glasgow, the first of which is the capital of Ireland, and a place whence a vast deal of provisions are sent to Liverpool, and the other is the grand emporium of Scotland, the third port in the three kingdoms, and the third, if not the second, town in point of population.

From the Humber and Mersey northward, to the border of Scotland, and even beyond it, there is no such distinct marking off of the land by estuaries. There are various coast-harbours on the east, and also the embouchures of Tees and Tyne, the last of which is a place of great trade; but the tideway does not penetrate far into the country. On the west there are also several estuaries

navigable for a short extent by craft of moderate burden; and the bay of Morecombe, and the Solway Firth, make a good figure on the map of bays; but, from the characters both of the coast and the tide, they are not well adapted for navigation.

The third of these great natural divisions of Britain includes a very considerable portion of the south of Scotland, and is marked off toward the north by the estuaries of the Forth on the east, and Clyde on the west, which approach nearer to each other than any others on the opposite side of Britain. The Forth is a very wide estuary for the greater part of its length, and the consequence is, that, though there are a number of minor towns and harbours along its shores, at which a good deal of shipping trade is carried on, yet that trade is mostly coasting, and there is no general emporium. One would suppose that Leith, being the port of the Scottish metropolis, would be a great shipping place; but such is not the fact; it is not well situated for a harbour; and there is no manufacture in the neighbourhood of sufficient consequence to require, and therefore to attract, shipping. With the Clyde, the case is quite different: in some respects, it is the best estuary in Britain; and, perhaps, as depending on trade, its shipping and population are increasing faster than those of any other large town in the three kingdoms. We shall, however, speak generally of it in another article, after we have put our readers in possession of some of the details by its very talented engineer.

The Tay is the next large estuary on the east coast; but excepting the Clyde, there is nothing answering to it on the west; and thus, in a topographical point of view, it nearly separates the county of Fife on the south, from those on the north. There are extensive banks in the entrance to the Tay, but, after a vessel has got fairly within these, the navigation is safe, and in some places it forms an anchorage approaching to the condition of a natural harbour. Dundee, in Fifeshire, is the grand emporium and port of the Tay; but it stands where the estuary is broad; and the city of Perth maintains a rivalship with it, though a very inferior one, and one in which Dundee is gaining ground every day.

The next section naturally marked upon the surface of the country, is formed by the Moray Firth on the east, and Loch Tinnhe on the west; but the Firth of Tay is not an estuary; and Loch Tinnhe, and indeed all the west coast from the Clyde northward, though abounding in bays and creeks, are in a wild and inhospitable country, and of small use to navigation. Northward of this there are bays and estuaries; but they are also of very minor importance. They do not penetrate far into the country, and the productions are few; and there are no manufactures deserving of name. Therefore, all the harbours and accommodations for shipping which occur upon this coast, are required only for coasting-trade, or for occasional refuge, and thus little can be afforded to remunerate the engineer for labour upon them; and fortunately not much is necessary.

Such is a general enumeration of the principal bays, arms of the sea, and estuaries, which indent the shores of Britain; and we shall compare their several merits and defects, when we come to treat of them in detail, which we shall do accordingly as we are supplied with authentic information. We now proceed to give some document with regard to the Clyde, delaying our general remarks until we have laid a considerable number of such documents before the public.

NAVIGATION OF THE RIVER CLYDE UP TO GLASGOW HARBOUR.

For these three summers past, particular attention has been paid to the clearing away of the hard bars in the bed of the Clyde. Those ridges in the bottom of the river have been operated on by the dredging-machines, and constantly on by the diving-bells; these last machines have taken up an immense number of very large stone boulders (whinstone), some of them more than three tons weight.

In consequence of so much heavy material having been cleared away from the bed of the river channel, ships drawing from 16 feet to 17 feet 6 inches of water, have, last summer, sailed up the Clyde, and have been berthed along-side of the quays in the harbour; the names of some of them were the Mohawk, Gensee, Canada, Belona, Caledonia, Sarah Botsford, Tecumseh, Lanarkshire, Ganges, Acadia, &c. The Ganges was a ship of 750 tons. It is expected that a ship drawing from 18 to 20 feet of water will very soon be able to sail up the Clyde into the harbour of Glasgow. At the end of this season, the ship Bellona, bound for New York, drawing 17 feet of water, sailed from the harbour of Glasgow down the river Clyde to the deep sea, in one tide.

It appears, by John Smeaton's report in 1755, that vessels drawing more than 3 feet 3 inches of water could not navigate the river Clyde up to Glasgow.

OBSERVATIONS ON THE TIDES IN THE HARBOUR OF GLASGOW, AND THE VELOCITY OF THE TIDAL WAVE IN THE ESTUARY OF THE RIVER CLYDE BETWEEN GLASGOW AND PORT GLASGOW.

READ BEFORE THE BRITISH ASSOCIATION AT GLASGOW, BY WILLIAM BALD, F.R.S.E., M.R.I.A., &c.

I have been for a considerable time past engaged in making observations on the rise and fall of the tides in the harbour of Glasgow.

I have thought it might be interesting to lay before this section of the British Association, the extent and results of these observations up to the present time.

The first series of observations made on the tides were commenced the 26th of April, 1839, and extended to the 1st October, 1839. They have been tabulated, and contain 158 observations of the rise and fall of the tides. It is necessary to observe that the first portion of these tide observations were only made during the day, and did not extend to the night tides. These 150 observations assign a mean rise and fall of tide in the harbour of Glasgow to be 6 ft. 7·20 in.*

In September, 1839, my kind friend Captain Beaufort, of the Admiralty, furnished me with four volumes of tide observations, made at the naval dock-yards of Milford-haven, Plymouth, Portsmouth, and Woolwich, and also written and printed forms for making tide observations. Being furnished with these valuable documents, I instituted a continuous series of tide observations during day and night.

The number of tide observations made in the harbour of Glasgow, from the 1st October 1839, to the 27th August, amount to more than 1200. I have tabulated them, and divided them into months; but such of the tides as have been much disturbed by

* Smeaton, in his Report on the river Clyde, dated 3rd September, 1755, states the neap-tides as only being visible at Glasgow bridge.

floods, I have rejected. By looking at the table for October 1839, the first line states from the 1st October to the 7th October; number of tides in the first column, 13; in the second column, mean rise and fall of these 13 tides is stated to be 6 ft. 5 in.; the third column, the mean low water of these 13 tides below top of south quay wall, in the harbour of Glasgow, is 15 ft. 8½ in. The fourth column shows the mean high water below the top of south quay wall to be 9 ft. 3½ in.; and the fifth column exhibits the mean half tide level below top of south quay wall, to be 12 ft. 6 in. The table shows the number of tides for new moon, first quarter, full moon, and last quarter. The total number of tides for each month, the mean rise and fall of tide per month, in column six; the mean low water below top of quay wall, in column seven; mean high water below top of quay wall, in column eight; and mean half-tide level below top of quay wall per month, in column nine.

The mean rise and fall of these 1213 tides, assigns an average of 6 ft. 8·98 in.; and the first series of 158 tides, assigns a mean rise and fall of 6 ft. 7·20 inches.

These observations have been in detail laid down graphically in section-form, a mode of representation which I had never seen or heard of having been done before; but Mr. Greenough, President of the Geographical Society of London, informed me, when examining these sections a few days ago, that a similar plan had been adopted in representing the rise and fall of the Elbe, and other continental rivers.

The detailed 1213 tide observations in section-form, show the time flowing on by a line divided into days and hours, along which is figured the time of high and low water, mean solar time. The figures at low and high water on the section, are those graduated on the staff; subtracting the one from the other, shows the amount of rise or fall in each tide; the curve line shows the movement of each respective tide during day and night; the dark perpendicular ordinates crossing the curve line, exhibit the rise and fall of each tide, and immediately below, is specified in figures the time of flowing and ebbing of each tide. The mean low and high water for the first quarter, full moon, last quarter, and new moon of each month, is marked by a single dotted line; and the mean half-tide level, by a double dotted line. The bottom and top lines of the south quay wall, in Glasgow Harbour, are also shown, and to which all these tide levels have been reduced.

I have drawn out 8 sections, showing the perpendicular rise and fall of the tide for every 15 minutes in the harbour of Glasgow, at Clyde Bank, Bowling Bay, and Port Glasgow.

I have also measured the velocity of the ebbing and flowing of the tidal current in various parts of the river Clyde, from Glasgow Harbour to Port Glasgow:—

VELOCITY OF THE TIDAL WAVE IN THE RIVER CLYDE, BETWEEN PORT GLASGOW AND THE HARBOUR OF GLASGOW.

FULL MOON 18th MARCH, 1840.

1840		Min.	Vel. per h.
March 18	Difference of time of high water between Port Glasgow and Bowling Bay canal mouth	33	= 14·54 miles
„ 19,	Do. do.	28	= 17·14 do.
„ 20,	Do. do.	40	= 12·00 do.
		3)101	3)43·68
		33	14·56 mean

Port Glasgow to Bowling Bay, 8 miles.
Velocity of tidal wave, 14·56 do.

Miles	5 Jan., 1840	28	
	6 . .	30	
20·81	7 . .	23	
	8 . .	40	
	9 . .	41	Mean velocity 13·71 miles.
9·60	10 . .	50	
		6)212	
		35 mean.	

1840		Min.	Vel. per h.
March 18	Difference of time of high water between Bowling Bay and Clyde Bank	45	= 6·66 miles
„ 19,	Do. do.	42	= 7·14
„ 20,	Do. do.	45	= 6·66
		3)132	3)20·46
		44	6·82 mean

Bowling to Clyde Bank, 5 miles
Velocity of tidal wave 6·82 do.

March 18,	Difference of time of high water between Clyde Bank and Glasgow	35	= 8·57 miles
„ 19,	Do. do.	25	= 12·00
„ 20,	Do. do.	25	= 12·00
		3)85	3)32·57
		28	10·85 mean

Clyde Bank to Glasgow Harbour 5 miles.
Velocity of tidal wave . 10·85 do.

Minutes.	
33	From Port Glasgow to Bowling Bay
44	Bowling Bay to Clyde Bank
28	Clyde Bank to Glasgow Harbour
1„45	difference of time of high water between Port Glasgow and Glasgow Harbour.

It appears, from the above observations, that the tidal wave runs from Port Glasgow to Bowling Bay, at a rate or velocity of 14·56 miles per hour; from Bowling Bay to Clyde Bank, at a rate of only 6·82 miles per hour; but from Clyde Bank to Glasgow Harbour, at a rate of 10·85 miles per hour. The diminished velocity between Bowling Bay and Clyde Bank, arises from the channel of the river being more crooked in that part, than any other portion of the river Clyde, therefore showing the great necessity of straightening and improving it.

WILLIAM BALD.

September, 1840.

1839	h.	m.
April 26..	7	10½
27..	7	11½
Full moon 28..	7	9
29..	7	10
Springs 30..	7	9½
May 1..	7	9
2..	7	2½
May 3..	7	8½
4..	7	8½
5..	6	8
6..	6	4½
Neaps 7..	6	9½
8..	6	8½
9..	6	9½
10..	6	5
May 11..	8	1½
12..	8	5
New moon 13..	8	7
14..	8	2½
15..	8	7½
16..	7	0½
17..	8	5½
May 18..	8	5½
19..	6	2½
20..	6	7½
21..	6	3½
22..	6	8½
23..	6	6
24..	6	10
25..	7	4½
May 26..	7	7½
27..	7	5½
Full moon 28..	7	6½
29..	7	8
30..	7	7½
31..	7	8½
June 1..	7	8½
June 2..	7	11½
3..	7	10½
4..	7	8½
5..	7	6
6..	7	8½
7..	7	7½
8..	7	9½

	h.	m.
June 9..	8	11½
10..	8	4½
New moon 11..	8	1½
12..	8	0
13..	7	5½
14..	7	4½
15..	8	0½

	h.	m.
June 16..	8	2½
17..	8	7
18..	7	7½
19..	7	2½
20..	6	10½
21..	6	9
22..	7	0½
23..	7	3½

	h.	m.
June 24..	6	10½
25..	6	8½
Full moon 26..	7	1
27..	7	3
28..	7	4½
29..	7	6½
30..	7	9½
July 1..	7	9

	h.	m.
June 2..	7	8
3..	7	8
4..	7	7¾
5..	7	6
6..	7	10
July 7..	7	8½

	h.	m.
July 8..	7	9½
9..	7	10¾
New moon 10..	8	0½
11..	7	2½
12..	5	10
13..	6	2½
14..	7	10¾

	h.	m.
July 15..	7	10
16..	7	6
17..	7	9½
18..	7	6½
19..	7	2
20..	3	9
21..	5	4
22..	5	4½
23..	5	3½

	h.	m.
July 24..	7	1
25..	6	11½
Full moon 26..	7	5
27..	6	8½
28..	7	5½
29..	7	5
30..	8	1
31..	8	3

	h.	m.
August 1..	8	8
2..	8	3½
3..	7	3½
4..	6	10
5..	6	4
6..	6	7

	h.	m.
August 7..	7	3½
8..	7	9
New moon 9..	8	0
10..	6	11½
11..	5	9
12..	6	10½
13..	7	0½

	h.	m.
August 14..	7	6
15..	7	8
16..	8	1
17..	7	0
18..	6	2
19..	5	7
20..	4	10
21..	5	3½

	h.	m.
August 22..	6	4½
23..	6	3½
24..	7	0
25..	7	3
26..	7	3½

	h.	m.
August 27..	7	3½
28..	8	6
29..	7	1
30..	6	7
31..	8	8
September 1..	5	10
2..	4	1
3..	3	11
4..	4	5
5..	6	10
6..	6	0½

	h.	m.
September 7..	6	10½
8..	2	5
9..	4	3½
10..	2	9½
11..	7	1½
12..	6	8½
13..	7	9
14..	3	6½
15..	5	5½
16..	2	0
17..	3	4½

	h.	m.
September 18..	2	3½
19..	2	6½
20..	4	8½
21..	5	4
22..	6	5½
23..	7	2
24..	8	3
25..	8	1
26..	7	2

	h.	m.
September 27..	7	7½
28..	7	5
29..	5	1
30..	6	10

[The diagram of the tide will be given in our next.—Con.]

BOWLING BASIN.

This basin is about 10 miles below the harbour of Glasgow, and 11 miles above the port of Greenock; it is situated on the north side of the River Clyde, below the entrance of the Forth and Clyde canal. It contains an area of fourteen acres and a half.

The works of this basin were commenced this season, and consisted of excavating a space within it of 1200 feet long, by 200 feet broad, to a depth of from 5 to 6 feet below low-water line; raising a rubble-stone dyke on the west side of its entrance; erecting a timber wharf 300 feet long on the outside of the rubble dyke, next the River Clyde, where large ships, either inward or outward bound to or from the port of Glasgow, might remain for a short period.

The dykes which enclose this basin, consist of common dry rubble whinstone,—a material to be had cheap and in great abundance, thrown down into slopes of about one and a half of base to one of height. There are thirty-six mooring-posts around it, consisting of strong timber piles, covered and protected from the friction of the ropes, by strong cast-iron casings. This basin, at high-water, has a depth of about 14 feet, and the bottom is soft, consisting of mud and fine sand.

At present, there are actually lying in this basin six large three-masted vessels, two steamers, a brig, a schooner, a smack, two sloops, two steam-dredging vessels, one diving-bell, and nearly eighty large punts.

The object of forming this basin was to accommodate all the idle vessels which might be lying up in Glasgow Harbour during the winter months, by which the harbour would be relieved, and the vessels would be even more safely and securely berthed in Bowling Basin, free from ice and floods of all kinds, than in the harbour.

The works of this basin have been extremely simple, and very cheaply executed, costing only but a very few hundred pounds. It is capable of holding at present more than 40 ships of 300 tons, but when completed, will be capable of holding 150 ships of 300 tons, and will be of immense advantage to the shipping and trading interests of the Clyde.

TO THE COMMITTEE OF MANAGEMENT FOR IMPROVING THE RIVER CLYDE.

Gentlemen,

It is proposed to make a safe resting-place at Bowling for the accommodation of large ships sailing up and down the river Clyde; and which is considered by many of the pilots, masters of the steam tugs, and others, would be attended with the most beneficial results to the large class of vessels engaged in the trade of the port of the city of Glasgow. A large ship might, by the first tide, reach Bowling from Glasgow Harbour, where she would be moored in safety, and the next tide she would pass over the Port Glasgow Bank with facility, and reach the deep open sea.

It has been proposed to deepen and also to widen the channel of the Clyde from below the mouth of the Forth and Clyde canal to the New Perch, lately erected next Friskey Hall, so that large ships might be water-borne at low tide. By reference to the plan, it will appear that it is recommended to pile along the outside of the existing river-dyke for a length of 300 feet, the piles to be distant from each other about seven feet; the tops of the piles to be about seven feet above high-water line. These piles are to be one foot square, and thirty-seven to forty-five feet long, and strongly connected together by walings, twelve inches by six inches, for the purpose of keeping the ships from rubbing against the river-dyke; and it is also proposed to have several strong mooring posts driven deeply into the ground behind the river-dyke, so that large ships may be safely and expeditiously moored at this place. It may be observed that the length along the river-dyke is about 1030 feet, which can be very cheaply, and with great facility, made

to accommodate shipping; and this portion of the channel of the Clyde will not be so liable to silt up as many other parts of it, because both the ascending and descending tidal currents have a particular tendency, on account of the form of the channel, to scour away deposits in that part of the bed of the river, on which account it is favourable for a resting-place to the shipping.

The plan exhibits an entrance from the main channel of the river Clyde through the river-dyke into a space lying behind it, which is covered at high water, but partly dry at low water. This space contains an area of 14½ acres, and a great portion of it might be, at a very moderate expense, deepened, by which it could be converted into a kind of asylum harbour or basin, fit to receive and accommodate any idle or unemployed vessels, which may incumber the harbour of Glasgow: during the winter months, when the river would be covered with ice, the large ships, steamers, and all descriptions of craft would lie within it in perfect security and safety, and it would, on that account, be, in my opinion, a most valuable appendage to the harbour of Glasgow, and the shipping trade of the river Clyde.

WILLIAM BALD.

March, 1841.

ADVANTAGE OF SUSPENSION BRIDGES, &c.

[THE following is a portion of a private letter, and not written with any view to publication; but we find it contains so much important information, that we cannot resist laying it before our readers; and we hope that the author will pardon us for so doing. —CON.]

I have heard that Mr. Dredge has been examining the vale of the Leven; I have not seen any of his plans or designs for a suspension bridge there. I have seen some of his designs in your work, and I think Mr. Dredge has very great merit; the arrangement of the material and principle are admirable. There are numerous situations in the Highlands of Scotland where suspension bridges could be erected with great advantage to the public; and could be cheaply and quickly constructed, extremely suitable to crossing mountain torrents as compared to heavy masses of masonry, which in many cases are in danger of being swept away. Narrow roads, accompanied by bridges on Mr. Dredge's principle, would improve every Highland district in Scotland; many of the districts are altogether without any communication by roads and bridges, and which might be so easily and cheaply opened up, forming the first step to the drainage and improvement of the numerous vales which everywhere intersect mountainous districts. The very first formation of these narrow roads would lay dry many hundred acres of wild land lying along the floors of the glens, and which might be readily converted into rich meadow land; and where green crops of every kind would grow luxuriantly, affording abundant means of feeding the cattle during the winter months. How many beautiful glens have their Hows, lying in a state of nature, a perfect morass, hardly fit to bear up a snipe. It will make a new epoch when the energies and capital of an enlightened nation shall be directed to the improvement of the land; when men of genius, science, and practical skill, shall direct the construction of embankments, drainages, and canals of irrigation; then the pestilential morass and swamp will disappear, and become a verdant and fruitful plain. The muddy bays at present under the dominion of the ocean will equal the richest lands in luxuriant production; and the very desert sand, under the genius of man, will become invested with a mantle of the richest verdure.

Have you read the particulars regarding the drainage of the marsh of Contentin, the marsh of D'Arles, and of the Etang de Rochford in France, by Buonaparte? There are some very interesting reports and plans by the late Baron Prony, chief engineer of France, on the drainage of the Pontin marshes in Italy and on the delta of the Po.

The laws passed by Buonaparte on the 16th September, 1807, for the drainage of the marsh lands in France, are extremely interesting. He had formed the design of draining all the marsh lands in France. He advanced the Dutch £300,000 to drain the Polder of Zevenhoven, east of Rotterdam.

What a field for drainage and improvement Britain and Ireland present; the waste and marsh lands of Ireland are a reproach to the British government; nearly five millions of acres, all level, free of bog land, resting mostly on limestone and limestone gravel, surrounded by an active, unemployed population, and whose labour per man can be had for eight-pence per day. Many of the poor labouring men sow their corn and plant their potatoes early in the season, travel across Ireland, sail over the channel to England, work there all the summer and harvest, and return to Ireland at the end of the season, with money to pay the rent of their plot of ground. These poor men have hardly any clothes; their dwellings in Ireland cannot be called houses; they have no furniture; their food is potatoes, and their drink is water. Such wretchedness is not to be seen among the people of any other nation in Europe, yet Ireland, in point of soil, is more fruitful than Britain; many of her rivers and lakes are deep enough for all navigable purposes; on her coast are numerous harbours, some of them the finest in the world; notwithstanding, look at her desolate condition! Here indeed is a country, worthy to be studied by the British monarch and the British statesman, and demanding amelioration in every department. But where is the monarch or statesmen, possessed of the reach of mind, and who would be able to extend improvement into Ireland, a country which cannot be denied is capable, under a wise administration, of becoming England's right-arm in power. What has any of England's viceroys done for Ireland during the last seven hundred years? What have commissioners of drainage, of fisheries, of boards of works, done for Ireland? Are the maritime works of Ireland, the roads and bridges, the canals, &c., of that country under any organized system? What is the state of Ireland's maritime trade, her manufacturing industry, her agriculture, her fisheries, &c., compared to that of Great Britain, Holland, or even Belgium?

I must conclude, but you shall very shortly hear from me again.

I am, my dear Sir,

Very faithfully and sincerely yours,

WILLIAM BALD.

Glasgow, Jan., 1842.

SKETCH OF MICHAEL ANGELO.

AMONG the illustrious men whose names adorn the annals of the arts, there is none more worthy of the careful study of young men seeking information than Michael Angelo. With the exception

of Raffaelle,—and the distinction between them is a difference of style rather than of excellence,—Michael Angelo takes the lead of all painters that ever existed, nor is it very probable that he will ever meet with a rival; at least, if we judge from the poverty evinced in the productions of modern painters, there is not one who imitates the style of Michael Angelo, far less comes up to him in the execution of it. In other painters we have happiness in expressing what the artist intends, every passion that can be thought of delineated to the life, and all characters represented with truth; still, human nature is the subject even of the choicest of these compositions, and if there be one who stands on the verge, as though he were about to bound into more lofty regions, that single and solitary one is Raffaelle himself. In many of the attributes of painting, Raffaelle is superior to Angelo; and the reason is easily seen: the whole heart and mind of Raffaelle was almost exclusively directed to painting, while Michael Angelo excelled in all the higher arts, and was also skilled in the sciences and in poetry. The natural result of this was, that Raffaelle studied his subjects with much more minuteness than the other, and though he never lost sight of becoming dignity, or degenerated to the mere labour of the Dutch school, there is in his works a clearness and minuteness, for which we look in vain in the works of any first-classed painter. Still, he never comes up to the sublimity of Michael Angelo, which is always present, and varies with the subject from the sweet to the terrible; and as no group, or even two individuals, can have a community of feeling in this way, the true character of Michael Angelo is to be sought in his single figures rather than in his compositions. By this concentration of the expression upon the individual, he is enabled to do what cannot be done by those who labour to couple the characters of individuals with the style in which they are grouped together. We can give any description of character to the figures comprising a group, and the group jointly; but no grouping will add to the expression of spirit, which is the very essence of Michael Angelo's works. In consequence of this, though he never violates the propriety of human nature, he may be said, generally, to rise above it, whatever may be the figures he delineates. All that is palpable to the senses as human is faithfully rendered; but there is a super-human sublimity added, which distinguishes him from all other painters, without destroying the truth of his delineations of human nature; and it is this which ranks him so high in the scale. So far as we can appreciate forms of beings of a higher order than man, the forms represented by Raffaelle are perfect, but they want the super-human spirit; and it is this which Michael Angelo breathes into his forms, and which constitutes their sublimity. Whether he is imitable by any other artist we take not upon us to say; but it is a truth that he has never been imitated with success. It is in the frescoes and cartoons that we find the sublimity; and it may be that such paintings as those which adorn the Sistine Chapel, owe something to their situations.

Michael Angelo is not so dry a colourist as the old painters, or perhaps as Raffaelle himself; for the sublimity and effect of his paintings depend little upon colour; for when we view him as a sculptor, we find the same sublimity in his works, even when human beings are the subjects. There is an indescribable something in Moses and in David for which we seek in vain in any other statues, ancient or modern; and though his sleeping Cupid is a sweet production of art, still it is sublimely sweet. In his master-pieces of sculpture, Michael Angelo generally chose the gigantic scale; and while this gave greater grandeur to his subjects, it made them also more open to criticism. Thus, in his sculptures, as well as in his paintings, there is nothing meretricious,—nothing where the art of the painter can be hidden by the blandishment of general effect: you see the whole subject, and seeing it, you must admire. Sculpture does not address itself so forcibly to the general mind as painting, but perhaps it is superior to all by whom it can be appreciated, and Michael Angelo affords an instance of this; for, of all the works of art which he had occasion to see, examine, and study, in his youth, the collection of sculptures in the garden of Lorenzo de' Medici appear to have been his prime favourites, and to have taken so strong a hold on his mind, that sculpture was through life his favourite art.

In architecture, Michael Angelo held a high rank, perhaps the highest one in modern times; but we do not get a distinct and separate view of any of his works in this way. That we are indebted to him for all that is majestic and sublime in the cathedral at Rome cannot be denied; but probably he appears to less advantage in that than if we could contemplate his work alone, and without the association of others. But this is impossible; for there is no getting a feeling of St. Peter's as the production of one artist, and that artist Michael Angelo; and the merit which we usually ascribe to him is a merit only of inference. History informs us that the inferiority of the structure designed by San Gallo, as well as the inadequacy of its size to receive the monument of Julian, induced Michael Angelo to destroy the old structure, and replace it by the present one; but still we cannot, though we know the contrary to be the fact, separate San Gallo from the design of St. Peter's. In all his architectural works, Michael Angelo laboured under some disadvantage similar to this; and hence we are never able to see the work and the artist, unmixed up with other subjects and actors.

In addition to his eminence in these arts of peace, Michael Angelo also possessed skill as a military engineer; and it is no mean tribute of respect for his talents in that science that they were admired by Vauban, who, when at Florence, had copies of them taken for his private use. It is perhaps as well for the world, however, that in peaceable times the warlike arts are forgotten; and in consequence of this, though the works of Michael Angelo in fortification were first-rate, as indeed was everything that emanated from him, they are now all but forgotten. In the early and rude stages of society, military works are almost the only public monuments of nations; but as society advances, and art springs up after art, such monuments speedily disappear. Accordingly, while the architecture, the sculpture, and the painting of Michael Angelo stand boldly out, and force themselves upon our notice, his military works have to be sought out with some diligence, and cannot always be found when we seek for them.

In addition to these arts,—a fraction of Michael Angelo's labour and celebrity, any one of which would have been abundant occupation and honour for any ordinary man, he found leisure also to be a poet; and, though his poetical labours, at least those which are handed down, be few, their writer shows how high a niche he could have occupied in the temple of the bards, had such been the bent of his inclination. The splendour of his other works conceals the more subdued radiance of his verses; but the few of these that he has left, are proof that they could have been produced by none other than a genuine poet.

While the student contemplates the works of Michael Angelo, or

their pictorial representations, and studies his character as an artist, it is difficult to refrain from thinking and inquiring what he may have been as a man; and in this respect he is eminently deserving of our highest admiration. In private life he was subdued, kind, and pious, and, though the admiration is different, it is not easy to decide whether we should most admire him as an artist, or love him as a man. His virtues were numerous, but they were all of that subdued character which does not obtrude itself upon society. But still, though he enjoyed, as he deserved, the highest admiration from men of first-rate eminence, he never displayed the slightest sycophancy of fawning upon the great. When, too, he was treated with indignities which he did not deserve,—and the instances of these were not few,—he bore them with perfect equanimity of spirit; and showed upon every occasion that he was too great for being insulted by ordinary men or ordinary means. The Popes, who at that time were men possessing the highest talents, were his friends throughout the whole of his life, and he was also in high favour with the more illustrious dukes of Tuscany. When, too, those of a different character treated him with incivility, he showed that he felt the indignity, but that he was above complaining of it. On all occasions, indeed, he conducted himself like one above both the praise and the censure of ordinary men, and he did this without any apparent feeling or display of pride—of exaltation at good fortune, or humiliation at bad. His love of his country was peculiarly strong; and when ill-used at Rome, the only feeling that he displayed was a wish to return to the land of his birth. Angelo found in Pope Julius II. a subject with which most men would have felt some difficulty in dealing; for, to a pretty high degree of talent, this Pope added a wilful and wayward disposition, and was upon all occasions more of the soldier than the priest. Yet even with this hotheaded Pope, Michael Angelo never had any altercation; but when upon one occasion, one of the domestics had treated him in a manner which he looked upon as supercilious, he ordered his goods to be sold, and marched off for Florence. As soon as Julius learned that the artist was off, he sent five separate couriers to order him back, but, paying no attention to these, he marched on. The Pope having occasion to go to Bologna on business, sent for Michael Angelo, and we believe advanced to meet him by the way. A bishop in attendance, who, from the well-known character of the Pope, apprehended a storm, turned to his holiness with the intention, no doubt, of interceding for Michael Angelo; but Julius mauled the officious bishop with his staff, and merely reproved the artist for making him come to him, instead of obeying the summons. The peace being made,—in fact there was none to make with the Pope himself, the artist returned to Rome and resumed his labours. This anecdote, trifling as it was, showed the independence of Michael Angelo more clearly perhaps than if it had been a matter of greater importance. Nor were occasions wanted in which his love for his native country, and the city of Florence, displayed itself very conspicuously. He devoted his talents to the fortifying of such places as required it; and when the city was assailed by an enemy, he took a forward position among its defenders. Upon no occasion of this kind, however, did he compromise that dignity of character which was conspicuous in him through life. The multitude of works in which he was employed, and the magnitude and grandeur of most of them, rendered it impossible for Michael Angelo not to accumulate a very considerable sum of money. Instead, however, of showing either avarice or parsimoniousness, the very opposite appeared in his conduct, though he never made any display of it. When employed on St. Peter's, which he was for all the latter part of his life, he positively refused to accept of any remuneration, observing, that to be employed in the erection of so splendid a temple to the Almighty was remuneration enough for him. But even in this, not the slightest feeling of ostentation could be traced; he appeared to be simply doing his duty, and quite satisfied with the discharge of that duty for his reward.

Michael Angelo stood upon too high ground for having any rival in any of the branches in which he was so eminent; and, indeed, there was but one man who could rival him in a single branch, and that was Raffaelle, in painting. But instead of Raffaelle evincing any jealousy of Michael Angelo, or showing the slightest indication of being mortified that one who was both a sculptor and an architect, should also be a painter of the very highest description, Raffaelle had the highest possible regard for Michael Angelo. Being admitted while Angelo was painting the ceiling of the Sistine Chapel, Raffaelle expressed both astonishment and delight; and feeling that, in some particulars, the style of Angelo was superior to his own, he instantly and readily became an imitator.

It is far too frequent that a man of such transcendant talents stirs up the envy, and often the malice, of those who are inferior, and they go about to lower him in the estimation both of his patrons and of the public, and ground their dislike upon that very superiority which should command their admiration. But toward Michael Angelo there was no feeling of this kind; for, on the contrary, he was esteemed and loved by artists of all degrees of ability. Whether this was entirely owing to the magnanimous superiority of his own conduct, we pretend not to say, but this must unquestionably have had a very considerable effect. Whatever might have been the cause or causes, Michael Angelo was universally respected while he lived, and mourned by all when he died.

To display such superiority as he displayed would be difficult under any circumstances; and it would have claimed for him high praise, even though he had been, and had lived, the only luminary in a sky otherwise dull and rayless. But the times upon which Michael Angelo fell were very different from this, and his merit of course increases in the ratio. He was born during that period of Italian history which must be regarded as the time of the grand revival both of the arts and of literature, and this bright period continued till the close of his life. A gleam of lambent, and, for a time, imperishable glory lit up Italy, especially during the fifteenth and great part of the sixteenth centuries; and though this was a placid light, it would have been quite enough to quench the gleaming of ordinary geniuses. Upon Michael Angelo, however, it had no such effect. He was like a brilliant, which glimmers but faintly in twilight, but gleams out in full splendour when the sun is in his meridian strength. He was descended of a noble family, but that was a minor matter, for the highest honour that any family could possess, was giving birth to such a person as Michael Angelo. He was born in 1474, and gathered to his fathers, after a long, laborious, and honourable life, in the year 1563, and in the eighty-ninth year of his age. It is often said, that study wears out the mind, and exercise the body, but Michael Angelo affords a strong proof that neither is true. He lived till beyond the average period of human life, and up to the day of his death his faculties were not in the least impaired. The fact is, that truth is diametrically opposite to the common belief; for it is the

indolent who are short-lived, and the thoughtless in whom the mind seems to decay.

Taking the whole character of this great man as we have given it in outline, there cannot be found a more useful or delightful study in the whole range of human nature.

ELECTRIC TELEGRAPHS.*

The discovery of the attractive and polar energy, in that ore called loadstone or natural magnet, is lost in the obscurity of the past; but there is little doubt that the first glimmering notions of it, which hardly amounted to knowledge, and not at all to science, excited no small degree of wonder, and were probably made the foundation of some superstition, as though the substance had possessed the attributes of a demi-god. When Dr. Franklin sent electric sparks across the river by means of conducting wires, and especially when he proved the identity of lightning and terrestrial electricity, the world rung with the voice of astonishment, although some time elapsed before any use of this electricity was discovered, either in nature or in the arts. So also, when Galvani, by applying wires from the opposite poles of his pile of alternate discs of zinc and silver, or zinc and copper, excited the muscles of a frog into motion, or made the dead body of an executed malefactor open its eyes, the marvel sped like wildfire, the philosophical world were all at work, and those who could wonder, but not philosophise, were in amazement.

There is this similarity between human beings and science, whatever that science may be, that they begin with a period of the marvellous; and during this period there is little or no knowledge. But after a time, knowledge begins to spring up, and, as it waxes, wondering waxes, until the whole tends to the maturity of knowledge, and the systematising of that knowledge into science.

It has been thus with the three subjects which we mentioned at the outset, and to one compound operation of two of them, at least, the title of this short paper has reference. In their early stages, nobody dreamed that there was any identity among them; and, according to the philosophy of the time, they were all looked upon as material substance, fluids of so rare and attenuated a nature, that they defied alike the balance and the microscope, and penetrated, and even passed through other substances, without leaving any aperture or trace of their passage. Now, however, it has been clearly enough established that they are not substances, but action; not different species of action, but merely modifications of one and the same; and that this action, still differently modified, is heat, and light, and growth, and life, and, in all probability, motion, from the slightest shift of its place in the minutest particle to the rotation of the earth on its axis, the revolution of a secondary planet round its primary, of a primary planet round the sun, and of the more mighty march of systems, and congregated systems of worlds, about some unknown centre in the immeasurable regions of space.

In a subject so vast we can readily imagine that there are stores of knowledge to be found, and applications to be made, far beyond our present comprehension, but a number of which will hereafter rise upon us, as they have heretofore arisen, when we are not seeking for them. Only a comparatively short time ago, the best skilled in the application of those energies would have been perfectly incredulous had they been told that, by means of electricity and magnetism properly applied, signals should be sent across the country with rapidity, and that one man in London and another in Edinburgh or Bristol, might be made to communicate with each other with almost the same rapidity as though they were hand in hand together. This has not yet been done for distances so long as those which we have named; but we have them to a sufficient length for showing that this is practicable; and that, where there any means of supporting and protecting the wires which convey the galvanic current, a man in England might hold discourse with his friend in New Zealand, which are, as nearly as possible, the antipodes of each other.

This mode of conveying intelligence has not yet come into general use, nor is it employed even in the government telegraphs; but it has been introduced on several of the lines of railways, and there is no doubt that it will soon become general on them, as it possesses advantages over every other means of conveying information, whether the road is or is not clear; and thus it is a grand safeguard against accidents, which, but for it, could not be avoided.

Mr. Cooke has been much employed, indeed, the chief and almost the only man of science employed in constructing, apparatus for adopting galvanism to railway signals; and his pamphlet on the subject, the title of which we have partially quoted in a note, displays no small degree of enthusiasm and warmth in favour of the system. Mr. Cooke is a constructor of the requisite apparatus, and therefore we must receive his descriptions with some discount, as must be done with those of every man who writes on his own scheme, or a scheme from which he derives or expects to derive a pecuniary return. Justice, however, constrains us to say, that Mr. Cooke can be received with less discount than most men similarly situated; and that he appears to hold his own interest, and that of the public, in a pretty equal balance. In as far as intention goes, this is the highest praise that can be awarded, and Mr. Cooke is entitled to it to within a very minute portion of the whole. His pamphlet shows pretty clearly that he himself thoroughly understands the subject; but we are not sure that his book will make the public fully understand it, though it will be the means of letting them know the value of the apparatus; for, that the public generally understand the rationale and working of any nice piece of machinery, though highly desirable, is not absolutely necessary, neither is it attainable. Viewing the matter in this, its proper light, Mr. Cooke's pamphlet is a boon of considerable value, though inferior to his actual labour upon the railways; and he well deserves the gratitude of all who travel on those lines, or are connected with them, and of none more than the proprietors of shares.

Before we say a word or two on the apparatus and its working, we shall just notice the benefit, the part of the subject on which, as might be expected, Mr. Cooke is most explicit, and dwells for the greatest length.

Scarcely had railways come into use before it was discovered that they would be subject to very serious, but not very frequent, accidents, in spite of all the ordinary precautions that could be taken. These accidents do not arise from the principle of the railway itself, and therefore there is nothing in it which can give warning that they are coming. If, indeed, bad workmanship is the cause of the evil, that can in general, but not always, be known before ill

* Telegraphic Railways, &c. By William Fothergill Cooke, Esq. London: Simpkin, Marshall, & Co.

occurs, by signs in the work itself. Thus, slips in the banks of deep cuttings, or of the sides of embankments, usually have forecast shadows which give warning of them; but in some cases the warning is so slight, that it is overlooked; and in others, the signs are not visible until after the evil is inevitable. These slips often occasion accidents, especially those in the deep cuttings; but these accidents are not of the most serious kind; and if a train runs in upon the fallen earth, and there is time to lessen the speed of the rearward carriages by means of the breakers, nothing of a very alarming kind happens. The worst accidents are collisions; and the most destructive collisions are those which happen when the two trains which come into contact are running in opposite directions, and both with great velocity. In such a case, the shock is given with the joint momentum of the two; when it occurs, both are injured, and if they have different velocities, the slowest one is apt to be shattered to attoms. These are, therefore, the accidents against which the managers of the trains ought to be particularly on their guard; but where there are double rails, such accidents are exceedingly few.

Mr. Cooke shows very clearly that none of the schemes proposed by the managers of railways, or suggested to them by Parliament, will remedy the evil. These precautions are all reduceable to two: vigilance and care on the part of the driver—he is a conductor, not a driver, for the engine would not go a bit the faster, though he kept continually flogging at it,—and keeping time with the greatest minuteness. These are all very well, so far as they go; and careful conducting and well-kept time are quite necessary, whether there be any other means of guarding against accidents or not. But both of them are imperfect: the conductor knows the nature of the obstruction or danger which is in his way, only as far as his vision extends; and ordinary signals are also limited both in distance and in the nature of the dangers of which the conductor is warned. Time, if the trains could always keep it exactly, would prevent accidents from simple collision; but it would give no notice of a fallen bank, or any other obstruction upon the rails; and therefore it is not, and never can become, a certain warning against accidents. It cannot do this even though it could be carefully kept, and, as the keeping of it never can be perfect, as unforeseen differences of speed will occur, it cannot be made perfect within its own range.

These points are plainly and forcibly stated by Mr. Cooke; and it is to remove or lessen them as much as is within the power of human ingenuity, in the present state of knowledge, that Mr. Cooke recommends the electric telegraph. He has, indeed, another object, namely, that of making single lines of rail answer all the purposes of double ones, and effecting a great saving in the expense. Where trains from opposite directions cross each other on the line, Mr. Cook proposes sidings, into which the one train shall go, allow the other train to pass, and then get back into the main line.

On lines where there is little traffic, or where trains moving in contrary directions are never on the line at the same time, the chance of collision is not greater than on the one side of a double line; and therefore there is no use in making such a line double. It is obvious, however, that this can be the case only on branch lines, where there is little traffic, and where the passengers leave the one terminus at one time of the day, and the other at another, which supposes, that the passengers remain for a considerable time at each terminus, or leave it there to go in another direction.

A single line, on which there is much traffic, and trains frequently passing each other in opposite directions, is the most dangerous form of railwaythat can be imagined. Collisions are of the most dangerous kind, and they are more liable to happen than on any other description of line, more especially in consequence of the sidings and self-acting switches, which are absolutely necessary for making the line workable. These, however, are all different modifications only, and there is no certainty of safety upon any one of them against collision, and especially against running upon fallen banks, and other unforeseen obstructions on the rails. Mr. Cooke points out these very clearly, though perhaps with an undue leaning to the single line of rails, and he proposes the galvanic telegraphs as the nearest approach to perfection that has hitherto been made, and in this we agree with him. To enter with any minuteness into the details, and the mode of working the telegraphs, would swell this paper to too great a size, and that part of the subject must be left for separate consideration, in which it can be made more clear. We shall therefore only farther remark, that the telegraph consists of a wire, or series of wires, which may be connected or disconnected at the several stations, as may be desired; and of a number of alarm bells, which call the attention of those on the watch, and signals under the alarm bells, to and from which the information is communicated. The wire is within a case to protect it from the weather; and the dial forms the front of a small box, upon the top of which the alarm bell is fixed, in a paper frame. In the centre of the clock, there is an arrow-shaped hand, which, when the telegraph is quiescent and out of use, lies perfectly horizontal. Inside the dial, there is a magnetic box, upon the same axis, and placed in the same direction, as the index outside; and of course this box also is horizontal, when the apparatus is out of action. The principle upon which it acts is this: when a galvanic current is sent along the wires on one side, the one pole of the magnetic bar is deflected upwards, and the other downwards; and the index is deflected along with it. If the current is sent in the opposite direction, the pole, which was deflected up, is deflected down, and the point of the index is brought below the horizontal line of the dial. When the point is above the horizontal line, it corresponds to the direction which is called "up," on the line of railway; and when it is below the line, it corresponds to the direction called "down;" and if the signal is a warning of danger, it is telegraphed from the direction in which the danger lies, and indicates, also, the station on which it is situated. By differences in the machinery, information of various kinds may be telegraphed. More complicated arrangements have been necessary, in proportion as the information to be sent is greater; but the principle is the same in them all. The action of the index is occasioned by the pretty well-known principle of a magnet, that if a galvanic current is sent through it in one direction, it is deflected one way from the line of the current, and if the current is sent the other way, the deflection is reversed. We shall find occasion to revert to this subject in some future number.

ANECDOTE OF THE LATE MR. NIMMO.

TO THE EDITOR.

By your number for the 1st February, I am glad to perceive that you intend giving notes of the characters and works of the great men belonging to the engineering professions. This will be of much value to beginners, as one of the most useful studies that can

be presented to them; but you must endeavour, in all cases where you can procure information of undoubted accuracy, to state the circumstances which induced them to prosecute their grand inventions and discoveries, as well as the steps bywhich they were led to those results which have been, and are, of so much importance to the world. The tale of these matters, if told in a proper manner, will be serviceable to adults as well as to the young, because we not only require to be taught at the outset, but to have our memories refreshed afterwards. Go on, therefore, in the good path which you have chosen, and the world will be much less grateful than I suppose, if it let you go without your reward. Farther, I am very much pleased to see that you have placed Mr. Nimmo in the fore-ground, for nobody better deserves that place. He was truly an extraordinary man, and his multifarious works will carry him down to futurity as one of the best benefactors of the human race. I regret that you have said so little of him, especially in his private character, the one in which it would be most desirable to have a full and minute account of him; but this is, perhaps, not attainable; for, in the case of a truly great man, the public achievements hide the private character. This is the more to be regretted, that, in the private character alone, that we can find the germs of those public labours which, when they come to maturity, are of such benefit to the world.

What I know of Mr. Nimmo, as a man, is almost entirely the echo of what was said by others, and so I cannot literally depend upon it. The result of the whole however, is, that he was as delightful in private as he was splendid in public; and that there was a strong dash of peculiarity in both. Whether we study the writings, or survey the engineering works of Mr. Nimmo, we find that he is in everything peculiarly himself, and not another; and though, in many of those cases where we have an account of the progress from the beginning, as, for instance, in his printed works, we are apt to doubt his premises, yet we invariably find that his ultimate conclusions are quite sound, and arrived at by the shortest road. In his writings, he is a remarkably close reasoner, and never loses sight of his argument, or allows himself to be carried away by matters foreign to the end in view. As an instance of this class of reasoning, I may refer to the article "Theory of Bascovitch," in Brewster's Edinburgh Encyclopedia. That is a subtle subject, and one which few understand; but Mr. Nimmo makes it as clear as a common geometrical truth, and brings it to the level of the most ordinary capacity; but still, though this is a subject upon which arestrong temptations to over-arguing, and veiling the philosophy with a mantle of logic, we find none of this in Mr. Nimmo's account of the thing, which is the more to be wondered at, that, from all we have been able to learn, he was passionately fond of disputation in private life. It was my misfortune to know but little of him there, for I was rarely in his company, and still more rarely with him in cases likely to bring him out. He was intelligent, and generally playful upon ordinary subjects; but, engaged upon these, he showed clearly that they did not, and could not, occupy his whole mind, the strength and range of which were represented to me as being truly wonderful.

One day, about eighteen years ago, I had the pleasure of dining in company with him at Mr. Telford's house, in Abingdon Street; and there I had some opportunity of observing his manner, though I had few of his words, which were bestowed almost exclusively upon Dr. Olynthus Gregory, who sat next to him at table, and who previously received most of his attention in the drawing-room. Mr. Telford was to leave town in the evening, and he had a meeting to attend before he started, so that he endeavoured to get the honours of his table over with as much dispatch as possible; and, consequently, he was anxious to sit down to dinner the instant that it was served up.

Before the company were called to the dining-room, Mr. Nimmo engaged in a keen dispute with Dr. Gregory, upon some subject which the majority of them seemed not to understand, or even to care about; but Nimmo was deeply interested in it. Telford was equally interested about his dinner, and the engagement he had after it; and the instant that the footman announced "dinner on the table," Telford marched off. The others went by sections, but not very long after each other, so that Nimmo and the Doctor and myself, who wished to see the end, were all that remained in the drawing-room. I should have been very glad to follow our host; but I wished to see, for I could not hear, the result of the argument. Nimmo seemed so absorbed in the matter, that he did not know what was going on, and then the Doctor was ever and anon casting hungry looks toward the door; but Nimmo had got him in a corner, and was prying at him with the argument; for which the Doctor appeared now to have no ears. While they stood thus, the footman came in with different announcements, "dinner will cool!" "dinner is cooling!" "dinner is getting cold!" "dinner is cold!" Doctor Gregory could stand it no longer, but repeating again and again, "I give up! I see it now. Mr. Nimmo, you are perfectly right," he broke away, and made for the drawing-room door as fast as his legs would carry him. But Nimmo caught him in the middle of the room, seized him by the button, planted his own legs a little apart, and said, with a determined voice, "You will stop, though, man, and tell me how you make that out, won't you?" The Doctor had a stomach for his dinner, but he had none for going through the steps, short as they seemed to have been, by which he had convinced himself of his former error, and the truth of his adversary. Not a word escaped from him but, "You are right, Nimmo, you are perfectly right!" and at every repetition, he made a fresh effort to gain the door; but Nimmo held him fast, and repeated his demand to be shown how the Doctor's conviction was made out, until at last Telford came into the room, delivered the Doctor from durance by main force, and pushing Nimmo before him, seated him on his right hand. The dinner, though not absolutely cold, had but a low temperature; but Nimmo was "roused" as long as Telford remained in the room; and when he went off to his appointment, he called Nimmo to act as his deputy, and a glorious chairman he made.

C.

WORKING DRAWINGS.*

A SUBJECT derives no merit from its beauty when living, or the symmetry of its form when dead, when it comes under the scalpel of the anatomist; and the blandishments of style, and the poetic fervour of a piece of writing, vanish under the scrutinizing analysis of the philosophic critic; and, just as the dissector of bodies drives his knife through the most symmetrical form without the least compunction, even so the analyst of language cuts all the garnish

* An Essay on Architectural Practice, being an attempt to supply a Guide for Students, &c. By T. I. Walker, Archt., F.R.S.B.A.

clean away, and that which, undissected, is all melody to the ear, becomes, under his hands, nonsense or jargon to the understanding. These two propositions naturally arise in one's mind, during a careful perusal of Mr. Walker's little book, and he himself appears to have been perfectly aware of their force and truth; for the subject which he brings forward and anatomizes for the benefit of students, "at their first entrance on the practice of architecture as a profession," is as homely and void of beauty and taste as anything that ever was christened "Church" by an episcopal fiat. For the intended purpose,—that of getting at once to the details of the working drawings, this is perhaps much better than if there had been any architectural blandishment to captivate the learner, distract him from the main subject, and retard him in his way. We are certain, too, that this homely and incongruous building suits its place better than if it had been one of more lofty pretensions. An elegant, and especially an ornate church, would be sadly out of place at Bethnal Green; for neither the reality nor even the name is known in that quarter, and thus a tasteful building there would be like "a jewel of gold in a swine's snout." Bethnal Green is a place which nothing can spoil, either in a tasteful or moral point of view; and therefore a church which nothing can ornament, is precisely the one for it: indeed, we feel fully convinced that no fabricators of new churches, numerous as these persons and their works have been of late years, ever suited a building more admirably to its neighbourhood than Mr. Walker has done in this instance; and had he achieved nothing more, he would have established for himself a very high character for architectural taste. So perfect is the congruity, that it could not have been a matter of accident, but must have been positive intention; and it is intention which cannot be too heartily admired, or too frequently followed, wherever the situation requires it. But this is not the only specimen which Mr. Walker has given us of his good taste, in appropriately suiting the building to the place. In such a situation as Bethnal Green, grace and ornament are both out of the question, as much as a tiara of diamonds would be out of place under the basket of a woman who sold green hastings in the summer, or living flounders in the winter. All this must be acknowledged by every person having any pretension to good taste, and especially by every architect. But, notwithstanding this, everybody does not see it, and not a few architects are among the most mole-eyed of the whole drove. But, though we should not like to see a tiara of brilliants upon the vendor of peas or the fish-woman, any more than we should like to see dancing pumps on a hodman or street porter, yet there is a certain something that looks quite in keeping upon each, and on the feet of the hodman or the porter, a pair of substantial, neat leather shoes, well hob-nailed in the soles and heels, are precisely what is wanted. Mr. Walker appears to have felt this, and to have suited the analogy to the church at Friar's Mount, Bethnal Green. We wish that all past builders of churches had followed his example, and that all future ones would do the same; for, since structures of that kind began to be erected in the low neighbourhoods about the metropolis, many of them form the most unseemly contrasts that can be made or imagined. So long as there were buildings of this description only in neighbourhoods of moderate gentility at the very worst, the state of things was a good deal better; and though the church might, in point of stone and mortar, be superior to the very best of the brick houses about it, yet well-fed cherubs, *à la Wren*, stuck at the springing of the arches, where there were any, and on the door posts where there were none, brought matters very pleasingly to an equality; or, if the chubby cherubs were not tasteless enough for the purpose, apologies for lions, unicorns, and other beasts, real or imaginary, were placed in ludicrous situations, such as those which crawl on St. George the Martyr. But, in the case of our present new churches, the vast number and competition of architects, and the effort which each one makes to render one church a trap to catch the building of another, there are no such compensations. It is true that there is one compensation which is more efficient than any, or than all of these, namely, the bad taste of the architects.

Where one of the new churches, meant to be classical, is placed, as is often the case, amid an extensive collection of hovels, having the windows patched with old hats instead of glass; tattered rags, made more dirty by attempted washing; pigs and poultry having full range of the mud heaps and the kennels, and the whole echoing dismally to the blows of the cudgel upon the costermonger's donkey; when shirtless men and shoeless women stagger in and out of the holes of the wall, and almost naked children yell by the dozen in the furnitureless apartments; when want, woe, and misery stalk the place like its perpetual guardian angels, and all is abomination to the sight, save that greatest of abominations to the feelings, the gin-shop, which towers over the hovels like Saul, and seems, in an architectural point of view, like the sooterkin of a Tadmor, or Palmyra, springing up in the midst of the wilderness of woe, or rather like a devouring spirit, which first eats the hard-earned pennies out of the pockets of the wretched people, and then draws the flesh off their bones—then, then is the new church in the worst style of the most tasteless architecture, not merely in incongruity, but an abomination—something at which a heart of flint would sicken, or eyes of pumice stone would be drowned in tears. No matter for the wretched patchwork of the new church itself; for, though it were made up of incongruous fragments, all bad in detail, and intolerable as a whole, it would not veil the incongruity. Be it astylic or stylic, in the first instance it looks a prison, which has turned Roman catholic, as appears by the cross on the top, or it is itself imprisoned, and shows gloomily through the row of columns, like a captive through prison bars. Even if it approaches to being classic, of antique or middle age mould, that only makes things the worse; for it seems a something which has been dropped in the very last place that one would expect to find it. The structures are, however, generally speaking, destitute of every kind of classicality; Greek, Roman, Norman, or that *pot-pourri* which is rightly neither, they are equally offensive, and we long for the humble structure, with no ornament save its Norman doorway, standing under the shade of its elms and its long-enduring yew, on the sweetest spot at some distant village. We are sick to the soul of marshy pools and whirling dust; and sigh for the retirement and sabbath-day repose of the village house of prayer, and the refreshing coolness of its embowering shades—or balmy zephyrs and a breathing shade. *O qui me gelidos*, &c.

But we are forgetting Mr. Walker's meritorious labours, and still more meritorious book; of the former we shall say no more, and on the latter we shall be brief. We look upon working drawings as the very best which can occupy the thoughts, the ruler, and the pen, of a young architectural student. The drawings upon which the wits of those recent architects are sent to wonder, bear, generally speaking, too close an analogy to the garnish and over-bedaubed churches, and other buildings, in which their masters—we dare not say instructors, seek for immortality, but find oblivion. The youth is

drugged with elevations and perspective drawings, the first fit only to stick up like cakes of gingerbread, to cover up the hole in a chandler's window, or like penny pictures against the panes, to hide the vacuity of the stockless shop of a suburban bibliopole; and the last good for nothing but the wall of a hovel or the screen of an ale-house. He who keeps his pupils employed in this way month after month, may, in the end, make them stiff and formal copying draftsmen; but he never will make them architects, even of the humblest description; for, though they should continue copying churches and palaces, with the most laborious attention, for dozens of years, that would not teach them to build even a pig-stye.

Mr. Walker's plan is a far better one, and one for which students of architecture cannot be too grateful to him. Instead of sending them nearly to starve at the outside, he gives them the anatomy, pointing out in detail all the parts, with their structures and uses. He begins at the beginning, and gives a description of the foundations and footings, regulating the expense and strength of these by the weight that they have to bear. We are not sure that he says quite enough about drainage, or under-floor ventilation; but as the floor itself is stone, elevated a little above the ground, and the under-floor works are vaults or crypts for sepulchre, of which "mouldy damp, and roapy slime," are attributes by prescription, perfect drainage and ventilation are matters of less consequence. While mentioning this part of the subject, we may however notice that it would have been as well had Mr. Walker said something about the method of managing wooden floors in dwelling-houses, so as to give them the greatest possible security against the rot, both wet and dry, as that is the plague-sore of modern houses, especially where the timber is not very good: here we may, in passing, remark that the fashionable mode of Kyanizing timber, by saturating it with the solution of chloride of mercury, makes it unhealthy; and, as for durability, it gets no more than if it were pickled with common salt in a bacon trough. It is true that this poisonous saturation destroys *Merulius lachrymans*, and all the fungi known by the name of rots, which grow upon or in decaying timber, or rather it prevents the minute species of these from vegetating; but that it actually prevents destruction of the timber, is not quite true, for under peculiar circumstances, timber, especially if bad, will crumble to dust, without the appearance of the smallest fungus. From the foundation, Mr. Walker proceeds regularly upward to the roof and covering of the structure, detailing and describing the several parts in a manner so clear and minute, that a student who does not understand them must be dull indeed. This is a second edition of only one part of Mr. Walker's book, the second part being devoted to the jurisprudence of architecture, or the bearing of laws upon buildings, which is a matter of importance, especially in towns where boundaries are often complicated, and party walls are numerous. The present part contains an appendix, expressing, in blank, all the items to be estimated for, and also the tenders expressed in gross sums. The forms of estimate will be very useful to the young architect; but the tenders depend so much on local circumstances, that they are of minor importance. Mr. Walker makes design the first branch of architecture; but no part of his work is devoted to it, which is perhaps just as well, if we are to judge from the exterior of the church at Friar's Mount, Bethnal Green.

THE NEW HOUSES OF PARLIAMENT.

The works of this splendid pile are now in active progress, and although the magnitude of the undertaking, and the many unforeseen circumstances which may occur to delay it, render the time of its completion a matter of uncertainty, it is still satisfactory to observe that no exertions are spared to hasten the progress of the works, and that, should the present favourable weather continue, a more than usual rate of proceeding may be anticipated during this spring. Another winter's experience has been added to that of last year in reference to the capacity of the magnesian limestone to stand the attacks of frost; and nothing can be more satisfactory than the sound state of all the blocks of stone which are dispersed over the site of the works. We did not observe a single crack or flaw in any of these blocks; and being assured that the severe frosts of last winter were equally unproductive of injury to the stone, we may conclude that it is more exempt than most other limestones from this particular species of destruction.

It is scarcely possible, without the aid of drawings, to convey to a stranger a correct idea of the proportion of the building which is completed up to this time. In general terms it may be said, that the whole river front is carried up to the second floor, on a considerable part of which the preparations are now being made for raising the iron girders of the floor. The east and west ends are also raised to the same height; the concrete is laid for the tower at the western end of the building, and the foundations for the tower at the eastern end are in course of excavation. The depth of concrete is seven feet four inches, and the Yorkshire landings, which are to cover it, are six inches in depth, and of immense superficial dimensions, many of them exceeding 150 square feet. These stones are the micaceous sandstones of Yorkshire, and are procured from Bramley Fell, and other places in that county.

There are at present six travelling cranes used on the work for setting the stones. Each of these consists simply of a crab fixed on a platform, which is mounted on wheels, and these wheels work on iron bars, which are laid down on longitudinal timber logs at a considerable height above the level to which the building is raised. The motion of the platform is effected by means of cogs on the periphery of the wheels, which work in a corresponding rack cast on the bars or rails on which they travel. This is the usual plan adopted for giving action to these travelling cranes, and is similar to that which was used on the earlier railways, before the practicability of communicating motion by simple adhesion was understood. The crabs have also a transverse motion on the platforms, and by means of these two motions at right angles with each other, the stones can be adjusted with the greatest nicety just over the precise spot they are to occupy in the work. Numerous temporary railways are laid down on the work for the purpose of conveying the stones on trucks from the sheds where the masons are employed in dressing them. The rails used are of a light description, exactly similar to those of the Croydon railway, being spiked or screwed down to longitudinal balks, without the intervention of chairs.

The sheds are conveniently disposed, and afford shelter to a great number of masons employed in dressing the stones. These are seen in all stages of preparation, some only scabbled or picked into a rough form as they come from the quarry, others undergoing the process of hammer-dressing, and picking with sharp-pointed

tools, while others are being finally dressed to a smooth surface with flat-edged tools or chisels.

The iron girders intended for the second floor weigh four tons each, and are tested by means of the Bramah or hydrostatic pump with a force of thirty tons. They are cast at the works of Messrs. Bramah, near Birmingham.

It is known to most of our readers that the principal stone employed in this building is the magnesian limestone, as recommended by Messrs. Barry, De la Beche, and the other commissioners appointed by government to inquire into and report on the various kinds of stone suitable for such a building. It was originally contemplated that this stone could be procured from Bolsover Moor, near Huddersfield; but it was soon found that the supply obtainable from this locality would be quite insufficient to meet the demand, in consequence of which, large quarries have been opened at Anstone, on the line of the same geological formation, from which place the greater part of the stone is now procured. The quarries of Anstone are situate about three miles from Roche Abbey, and about twelve miles east of Sheffield; they are in the hands of Messrs. Grissell and Peto, the contractors for the building, so that the supply and the qualities of the stone, with respect to size and other particulars, are in their own control, and not subject to be affected by the caprice, negligence, or spirit of extortion, which not unfrequently characterise proprietors who command the exclusive supply of an important stone like the one in question. The magnesian limestone differs from most other limestones in containing a less quantity of lime, and a proportionably greater quantity of silicious matter: hence the crystalline structure arising from the presence of lime in the mountain limestones, and many other hard calcareous rocks, is almost wanting in the magnesian limestone. It consists in fact of an assemblage of amorphous grains of silex united by a calcareous cement, of such strength as to impart to the stone a great degree of toughness, and to destroy in it all that brittleness and liability to fracture by a slight blow which belong to many quartz rocks. The stone is accordingly tough and close, and although it imbibes a considerable quantity of moisture, yet, as we have before said, it is not liable to injury by frost like many others bearing the general name of limestones. The colour of the stone when first quarried is a brownish yellow, not unlike that of coarse brown sugar; but when tolerably dry, as when it has been under cover of the sheds for two years, its colour is a delicate cream, almost approaching to white. Some of the older stones, when first set in the work, present this white appearance, but they soon, particularly after rainy weather, resume somewhat of their former yellow colour, but of a shade not so brown as when they contain the quarry water. Like most other free-stones, it is softest and easiest to dress when first quarried, but even when dry, its uniformity of texture, and the almost entire absence of harder veins, render it a good free-working stone in the hands of the mason; and it is not productive of that injury to the points and edges of the tools, which is so highly objectionable in many limestones, and in most of the harder free-stones. A tolerably good polish can be put upon the stone; and it only requires the advantage of a white colour to render it valuable in ornamental decoration.

In addition to the magnesian limestone, the Bath stone from Painswick in Gloucestershire is employed for some of the more ornamental parts of the work. The extreme ease with which the Bath stone can be cut into the most elaborate and intricate forms, renders it superior to all others for carved ornamental masonry. Like most members of the oolitic series, the Bath stone consists of small round grains of silex, held together by a calcareous cement. Its structure closely resembles that of the roe of a fish, and it follows from the form of the grains, that the properties of toughness and adhesion are much more feebly possessed by this stone than by the harder and denser, or closer grained magnesian limestone.

We connot conclude this brief notice without alluding in terms of high praise to the workmanlike spirit of order which pervades the whole of these large works. It has been our lot more than once to witness with pain in the course of some large undertaking but too many indications of slovenly management on the part of the contractor, and this sometimes prevailing to such an extent, as to create a very reasonable surprise when the result or completion of the work has happened to turn out anything short of absolute ruin to the contractor. But, on the contrary, throughout the works of the new Houses of Parliament all is order and regularity; every implement and every piece of machinery seems exactly adapted for the purpose to which it is applied; there is no deficiency of machinery to hinder and cripple the progress of the works, and no useless lumber to throw obstacles in the way. We are of opinion that high credit is due to Messrs. Grissell and Peto, the contractors, for the able and efficient manner in which they are carrying the designs of the architect into effect; and we take this opportunity of returning our thanks to Mr. Allen, their superintendent on the works, for his polite attention, and for the courtesy with which, by permission of Messrs. Grissell and Peto, he afforded us every information we requested.

PLAN OF A NEW BREAKWATER.

TO THE EDITOR.

SIR,

As much attention has been lately attracted to the plans of Captain Taylor for providing harbours of refuge by means of floating breakwaters, I am induced to suggest to you the practicability of forming a breakwater on a plan, more simple, certainly, than the formidable constructions of Captain Taylor, but which I respectfully submit would be found useful and effective.

I am far from wishing to detract from the merits of Captain Taylor's really scientific and ingenious invention, and most willingly concede to it the praise so justly its due: my plan is of too unpretending a character to place on a footing of rivalry with his, and perhaps is scarcely adapted to the purposes for which the patent breakwater is intended. I think, however, it is practicable by a more simple combination of materials to construct a breakwater sufficiently effective for certain situations, where, for instance, it is required to preserve the foundation of a wall or the foot of a bank from the wash of the sea. It would also be useful to form a harbour on a small scale for boats, fishing craft, &c.

My attention was first called to the subject of breakwaters a short time since, under the following circumstances. I was applied to by some gentlemen having property on the sea coast to report on the best means of protecting an embankment or sea wall from being carried away; the sea having encroached on the land, and by the wash, or continual action of its waves, gradually undermining the foundations. On an examination of the ground, I felt some

diffidence as to the remedy I should propose, none of the usual modes of proceeding in such cases appearing exactly applicable to the case in question. After some consideration I was induced to recommend, what I believe to be a novel expedient, in the formation of a floating breakwater on the plan I shall presently describe, conceiving, that if I could break the force of the water before it reached the foot of the wall, it would strike harmlessly against it, and prevent the loose sand on which the wall had been built from being carried away.

I dare say, Sir, you, in common with many of your readers, have observed, that under the *lee* of any floating body there is comparatively smooth water, and that in very rough weather boats may safely go alongside of a vessel to leeward: it is also a common practice to float boats under the lee (or protection we might term it) of a boom, or other spare spar. Following out this principle (if I may so call it), I thought that if several pieces of timber, properly put together to form a species of raft, could be moored in such a manner as to catch the whelm, or curl of the surge, it would break it into small water or foam, and by destroying its weight, render its fury innoxious.

To produce this effect, I took three pieces of rough Memel timber, feet long and 14 inches square, placed them parallel to each other, and about two or three feet apart. These were braced together by cross pieces on the upper and lower sides, bolted right through, whilst diagonal braces bolted through in the same way gave additional strength, and prevented the main timbers working off the cross pieces by a side or diagonal strain. The whole construction would thus closely resemble a common framed hurdle, of gigantic size.

Mooring chains of lengths proportioned to the depth of water are attached to ring-bolts in the ends of the cross-pieces, and secured to heavy blocks of stone or mushroom anchors deeply bedded in the sand.

Several of these sections or lengths, being placed in a line along the beach, are moored at such a distance from high-water mark, and from each other, as to take the full force of the breakers, and the whole is found a very effective defence to the foot of the wall, and perfectly satisfactory and efficient for its intended purpose. To use as a protection to small craft, within which they might lay in smooth water, it might be advisable to have another line—the second or outer line being so arranged as to fill up the intervals between the sections of the first.

I have very slightly sketched out my plan, but I think it will be readily understood. And should any of your readers feel interested in the subject, I shall be happy to afford every information they may wish for.

I am, Sir,
Your obedient Servant,
EDWARD LOMAX.

Queen Square,
St. James's Park.

NOTES BY THE CONDUCTOR.

So far as we know, the above sketch by Mr. Lomax is the first proposed application of wooden hurdles, or beams floating on the surface, as a permanent breakwater against the sea; but the principle itself has been acted upon, at least for temporary purposes, though it, and the mode in which it acts, have by some means or other been neglected by most engineers. The small harbours along the south shore of the Moray Firth, are most of them subject to a violent swell, which rolls onward not only from Norway, but from the very shores of the Polar sea. This swell, however, is not a current of the water striking onward like the current of a river, for very often, when the swell is heavy, the current, which is never very extensive in the Moray Firth, sets in the opposite direction. The tide wave of high-water in the Moray Firth, is a sort of bay or drop-tide of the great southward undulation of the tide along the east coast of Britain, which meets the direct wave from the Atlantic somewhere near Deal, or more toward Dover, or the North Foreland, according to the state of the weather. As the inbend of the Moray Firth, especially along the southern side where there are no small bays, is very trifling, there is never much current; and, as we have said, the tide-wave at some distance off shore sometimes sets in a contrary direction, the result of which necessarily is, that there is no current on the shore, notwithstanding the violence with which the swell strikes there. It is a swell of waves, which act upon the coast in a very different manner from that in which a river acts upon its banks; but this difference we shall explain afterwards.

In excavating the new harbour at Lossimouth, great annoyance was occasioned by the swell, more especially as the works were carried on in the winter. A small portion only of the excavation could be done at a single tide, as the contractor had been misled by the local authorities respecting the time at which the water was back. To obviate this, a puddled tank strongly faced with stone, was put up in the west part of the harbour, or opposite the entrance. But, though the wall of this tank was further fortified by large masses of rock placed to seaward, the water assailed it with great violence, and tore these large blocks from their places, not by any current sweeping along shore, for of such there was none to speak of; but from the stroke of the waves, of exactly the same kind as the sea strikes all currentless shores by the waves only. To protect this wall of the tank, and so get a longer time to work at the excavation during each tide, Mr. Thomas Hughes, the contractor, moored a series of wooden beams in front of the wall, in consequence of which the destruction was greatly lessened and nearly obliterated, except during the most violent swells; and thus, by means of these beams or booms, the violence of the waves, which formerly tore the blocks of stone from their places, was broken, and the operations carried on with ease and success during a much longer time of each tide. These booms were first used by Mr. Hughes about the end of 1839, or the beginning of 1840, that is, about two years ago. We have felt it our duty to state this from being conversant with the fact, but it does not interfere with the right of Mr. Lomax to his application of the principle as a breakwater.

As his short paper did not come in time for getting his sketches engraved, and as they are exceedingly simple, we trust we shall be able to make his notion perfectly intelligible and plain, without the assistance of engravings.

The breakwater consists of a series of stout wooden hurdles or frames, with three bars at right angles, not far from the ends of each, and diagonal braces, crossing each other from angle to angle between the pieces of the frames. The longitudinal section consists of five pieces, one at each side, under the lateral bars, and one under each part of the frame. As many of these as are necessary are moored by chains and mushroom anchors, or great stones, at the ends of the different diagonals, and the whole are ranged with

a slight curvature, convex to the sea. Outside the openings, there is, when the waves beat strongly, a second set of these moored hurdles or platforms, making, with the inner or first set, a continuous breakwater, which completely checks the fury of the waves from the one end to the other.

We shall now briefly advert to the difference between the action of waves on the coast, and that of the current of a river upon its banks, because it is in the overlooking of this, that the grand danger lies, to which sea walls, whether for mere protection of the land, or for harbours, are exposed.

The river cuts upon its bank by a current sweeping along, which undermines only when the said current is confined to the lower part, and wears away the bank from top to bottom if the channel along which the current sets against it is always full. The debris, which is worn away by a current running along the bank and setting against it, is always carried downwards in the direction of the current, and lodged at a greater or less distance from its original situation, according to the size of the disrupted masses, and the strength of the current.

On the other hand, when waves strike against a coast, they always give their shock up and down, or in a direction crosswise to that of the river current; and, though the wind or other causes may give them the appearance of a current setting shoreward, or in some other direction, they are, in reality, only undulations of the water, resembling in the time of their rise and fall the vibrations of a pendulum, extending from crest to crest of the proximate ridges, and in their vibration for different distances, varying, like other pendulums, as the square roots of the lengths. These ridges of waves, when they are thrown into motion, strike upward and downward in their vibrations, which are increased by the wind blowing against a bold shore, but this not beyond a certain depth. The turning points are those in the horizontal line across the waves, so that the quantities of water elevated and depressed are always equal to each other; but, if the waves fairly reach the bottom of the water, the shock given by the underpart of it is the most violent; and the tendency is to break the coast perpendicularly, or probably to undermine it, and then batter it with the fragments.

In the case of a river-current which cuts the bank, there is no cure but in a sufficient strength of embankment, and such a new direction as shall send it away from the part cut upon, the effecting of which is, in the case of strong currents, the only means of cure. In the case of waves striking a shore, there is an easier means of cure; and, though the sea be all-powerful considered as a whole, the swells of it are much more easily dealt with than a strong current. If we destroy the undulations at such a distance from the shore as shall prevent new ones from being raised in the intermediate waters, we put an end to the destructive influence upon the coast. With a floating breakwater having little depth, such as that proposed by Mr. Lomax, the destructive force is destroyed on the coast, and not transposed to the breakwater, as it would be if that were solid. Say that a breakwater of masonry, or other solid matter, were made use of, it would no doubt more or less protect the coast from destruction, but it would do this only by taking the injury upon itself. Hence it is, that solid breakwaters are, generally speaking, so subject to destruction, and so expensive to keep in repair. A floating breakwater, like the one alluded to, would cure the evil, by reducing the undulations to a mere trifle of their height, and by this means it would be more effective than a stone breakwater, and could be executed at only a fraction of the expense. It is a kind of structure which cannot be undermined by the water, and as its resistance to the whole body of the water is small, though quite sufficient to stop nearly or altogether the effect of it upon a bold coast, it lets the smothered water pass through below the wooden frames, in which situation it has little effect upon the breakwater itself. It is singular that engineers, and those generally engineers of knowledge and experience, should fall into the error of preferring the solid breakwater; but this is only one of the instances in which want of knowledge so ties down the party, that he loses sight of the distinction of good and evil.

REMARKS ON LORD NORMANBY'S BILL FOR REGULATING BUILDINGS IN LARGE TOWNS.

It is a perilous matter to deal with the black letter of the House of Commons, even though there is nothing that can be called libel in the case. Indeed, it is perhaps the impossibility of libelling a public body, which renders the honourable House so dangerous to deal with; for, where nothing is a calumny, and people have the power in their hands, anything that they choose to consider as such is of a libellous nature. This consideration would, upon any ordinary occasion, be sufficient warning against even meddling with the black letter; but there is at present before the honourable House a subject of such importance, that we are induced to grapple with it, braving all hazards of the black letter, and even the greater hazard of the said bill being brought down from the Lords. This is what is, by way of eminence, called Lord Normanby's bill; and there are good points in it, though there are also some which are of a doubtful character.

With the preamble, no fault can possibly be found. It sets forth, that, "Whereas disease is engendered and aggravated by the crowded and unhealthy manner of building the dwellings of the working classes, in the large towns and populous places in this realm," and every one in the least acquainted with the subject must subscribe to the truth of this statement. Next come the enactments, which are of somewhat more doubtful character. The justices of the peace, or their quorum, are to be commissioners, unless in boroughs, where the powers are vested in the town councils; it is the same with the Scotch burghs, and in the county places of Scotland the sheriff is to be commissioner: with this we have no fault to find, providing that corporations and sheriffs are what they ought to be; and any change against them is more of a presumptive than approved nature. The surveyors under the act, by whomsoever they may be appointed, are not to be surveyors to the parties appointing them. Literally, this is good; but in reality it is somewhat questionable, inasmuch as the appointed can be no better than the appointer. The council or justices are to fix the districts, and administer a declaration that he shall do his duty to every surveyor and assistant surveyor, when he is appointed to office.

Three days before a building shall be begun, or any additional alteration be made, or any structure be built or rebuilt, notice is to be given to the surveyor by the master builder, or other party who is to conduct the work; and this notice is to be left at the office of the surveyor, and to state the nature of the intended work, the name and place of abode of the managing party, and all other necessary particulars. And if the local surveyor shall not have it in his power to attend, he is to appoint another, and in the event of

that other not having it in his power to attend, some of the deputies shall attend; but here no provision appears to be made for small towns.

If the provisions of the act are violated by the builders or others, the surveyor or assistant shall immediately, on making his survey, give notice that the act is departed from; and if the departure is not corrected within forty-eight hours, notice thereof is to be given to a justice of the peace, if in England, and to a sheriff if in Scotland. The clauses of regulation as to obeying the act are so clearly stated, that it is unnecessary to comment much farther upon them, only that the builder making the alteration or causing it to be made shall, within one calendar month of the completion, give notice that the building is finished, and declaring its conformity with the act, in order that the said building may be viewed by the surveyor, who is periodically to certify the agreement of new buildings with the act. Before, however, the commissioners under this act grant a declaration in favour of the building, they must get a certificate from the commissioners of sewers, certifying that the said building is drained in an efficient manner, as by the act for better drainage is provided and appointed. This is a very important part of the matter; because, as the case has hitherto stood, some very crowded neighbourhoods, even in London and its vicinity, and notwithstanding the previously existing acts, may be said to have had no drainage at all, for they had none but surface drainage by the gutters of the streets and lanes. Under these acts, some localities were well drained; and though the reason of this preference in the way of drainage might perhaps be easily and accurately pointed out, that is not necessary; suffice it to say, that we have known one extensive district, in part of which every house had a separate and perfect drainage, while in other parts there was no drain whatever, and yet the undrained places were as highly taxed in sewer rate as those in which the drainage was perfect. We hope that these new acts will correct such glaring inequalities; and that one will secure dry foundations, as the other enforces proper structures to be erected upon them. During the period that elapsed between the demise of the former bill, and the introduction of the new edition, it appears that it has been carefully studied, so that the new bill is a very decided improvement on the old one. We understand from what we consider the most unquestionable authority, that the subject is yet to be thoroughly sifted, by the obtaining of a great body of evidence after the bill gets into committee in the Commons.

This is an admirable means of proceeding in bills which involve fiscal regulations, and many details for improving the accommodations of the people. The old plan, which, however, has been gradually becoming obsolete, usually passed in its first form; and if it did not work, it was sent back again, and again, as might be required. This mode of proceeding did not increase the reverence of the people for the House or its members; it occupied much of the time of the latter, and brought subjects before them at such long intervals as that they forgot the beginning before they came to the end. These bills, by being revived again and again in the House, will not be so certain of effecting their purpose as if they were experimentally tried; but the members will understand them more thoroughly, and so be able to do their duty more effectually.

The clauses which form the essence of the present bill are those that relate to the disposition, size, and ventilation of the dwelling and sleeping apartments, of which a large proportion of the working class in towns have generally only one, and have hitherto had that one ill ventilated and unwholesome, almost in the proportion of the necessity of having it good in these respects. Of this, however, we shall say a few words afterwards.

Clause 15 enacts, that it shall not be lawful, within the limits of the act, to build any house in which the cellar or underground part is to be inhabited, unless there is an open ground area, three feet wide, at the front and back of such cellar, extending from one party wall to the other. But this not to interfere with any archway or covering leading to the door of the house above.

Clause 16 enacts, that every underground apartment let as a dwelling shall have a window and fire-place, as well as an open area outside, and that cellars without windows and fire-places, though attached to the apartments which have these and may be occupied along with them, are not to be let separately, excepting as warehouses or stores. These classes apply to new buildings to be erected within the limits of the act, and of course take place immediately upon its passing.

Clause 17 enacts, that all under-ground apartments, built previous to the passing of the act, shall, on the first of January, eighteen hundred and forty-four, cease to be inhabited as dwellings, unless otherwise ventilated and having an area of at least two feet wide, or after the first of January, eighteen hundred and fifty, unless they have an area of at least three feet wide. This of course refers only to apartments occupied by the poor as dwellings.

Clause 19 enacts, that all houses, except corner-houses, shall be built with twenty feet of space between the back of one house and the back of the opposite—it being understood that these houses are built fronting parallel streets or lanes, with the fronts toward each other on the street side, and the backs on that of the yards or back-areas. In estimating these back-areas, no notice shall be taken of out-buildings, unless they extend for more than two thirds of the length of the house, or be nearer than seven feet to any other outhouse, and they are not to rise more than eight feet above the level of the street or walls.

Clause 20 enacts, that no street, alley, or public passage, within the limits of the act, shall be less than thirty feet wide, if there is a carriage-way, and twenty feet if there is no carriage-way.

Clause 21 enacts, that it shall not be lawful to build any alleys or courts, except mews and stable-yards, narrower than thirty feet, unless there is a clear passage of twenty feet and upwards through each of the said courts or alleys.

Clause 22 enacts, that the ground floor of every such house, built within the limits of this act, shall be at least six inches above the street or foot-way leading to the same. The object of this last enactment is to admit a current of air from the part of the house below ground to ascend freely to the atmosphere by means of the open vent in front or in rear of the house, as may be. The set of clauses now analysed, have for their object the ventilation or healthiness of those underground floors by means of a free circulation of air between this underground portion and the open street, or roadway, without. In that state of things where there is no ventilation, the under-ground floor has a warm atmosphere, and if there are the means of supplying its place, this atmosphere would rise upwards, and be thereby deprived of much of its unhealthy character. As long as the cellars were without any aperture save the door—and this was, and is now, the state of them in many parts of London,—the air stagnated, became impregnated with the most deleterious miasmata, and the wretched cellars, inhabited as they were, were the perpetual abodes of disease, of the causes of which there were no means of getting rid. This, however, will be

effected by the plan proposed in the bill, and that in a manner by no means inefficient.

Clause 23 provides for the regulation of the interior of houses. There shall not be two stories in the roof of any such house; and the upper story of the topmost floor shall not be less than seven feet in height. The rooms in the principal part of these small houses to be eight feet high at the least, and each house to be provided with a privy, drained in terms of the drainage act. We need give no details of the middle portion of these houses, further than that it is enacted that the building shall be substantial, and the party-walls such as to prevent as much as possible the spreading of fires in such houses; the parts which require the greatest protection from the legislature are the dwellings constructed below ground, and those which occupy the roofs of the houses in more than one story.

All the leading points of these most necessary and important improvements are provided for by Lord Normanby's Bill, in a manner which strikes us as being very efficient; and if the execution shall fail from any cause whatever, Lord Normanby will not be answerable for that failure. We do not anticipate the occurrence of any such, and we are sure that it is not necessary; but the scheme interferes greatly with private interests, and these are the interests of parties who care little as to the mode in which these interests may be promoted; and for this reason perhaps it would have been as well if the bill had been made a little more stringent, and had been more exclusively directed against the owners of the houses.

Still we are thankful for the bill, even in its present form, and coupled as it is with the Drainage Bill; and, as we have already said, we have great reason to hope that it will be much improved before it becomes the law of the land. Good, however, as the bill is in its present form compared with the wretched system of which it is expected to make an end, we look for further and very extensive improvements. Every effort is making to expedite its progress, but not with the slightest view to hurrying it through parliament as a crude and unconcocted measure. The object is quite the contrary; it is to get plenty of time to examine all the evil which is in the bill, and ascertain all the good of which it is susceptible.

For this purpose, as we have said, it is intended thoroughly to investigate the bill in committee. Not a committee of the whole House, though nominally it may be there, but a committee up stairs, where it is understood that a bill of this description can be better managed than would be possible in the whole House, occupied as the members are with matters of many descriptions. The belief is, that its removal to the whole House is intended to make the members acquainted with the bill, so that they may wash it from all its impurities; and hence it is presumed that it will be kept before the House as long as possible—as long as to nearly the time of prorogation, when the session closes; and, further than this, our informant adds, that, should such a measure be necessary, it will be thrown out in the mean time to be introduced in substance afterwards.

For the analysis of the bill, and several of the remarks on it, we have to acknowledge our obligations to Mr. Denton, of Gray's Inn, Surveyor,—a gentleman who takes a very deep interest in everything connected with improvements analogous to that set forth in Lord Normanby's bill; and who, in his letter to us, expressed his anxiety that the profession should entertain the bill, and advise on its details in its progress through the House of Commons.

Having said thus much, with a wish to reciprocate his views, we would now very briefly call the attention of the observant to the state of the country when there either was no act of this kind, or when the violation of it was winked at, and contrast it with the new state which would result if this bill passed into a law, and was duly administered. This, it is true, is not a perfect comparison, as the first is a real state of the country actually observed, or might have been observed, and the other is in the mean time only a hypothesis, and, at best, it has no foundation but the presumed working of a bill, which has not yet passed into a law. Still, the former state of things was so bad, that it is impossible to imagine any comparison of which it shall not be the worse member. The new bill strikes at what may be considered as the very root of the old evil. Its objects are to compel landlords to ventilate cellars used as habitations, by the very construction of the buildings themselves, and to prevent, by similar means, two sets of families, the one over the other, from inhabiting roofs. To judge of the first of these abominations, one has only to walk along the street in a low and crowded neighbourhood, and notice what is seen there. Of the roof habitations, it is not so easy to get an actual and adequate view, because we look up at a roof, and see only the eaves. But the judgment of reason is little less strong in the one case, than the evidence of sense is in the other; and in both of these there is too much to be seen for being borne by a person of any feeling. The cellar habitations are very bad, even in streets where the upper parts of the houses are of rather superior character; and where wretched habitations extend from cellar to roof, they are perfectly loathsome. Two or three little sweeps reposing upon their soot-bags, or parturient females and diseased persons stretched out upon the floor, without a rag over or under them, are daily sights, from which one turns away with something like pleasure to an Irishman, with his wife, children, and pig, also on the naked floor; and all these dwellings without fire, or light, or ventilation.

In as far as the cup of human misery in a dwelling place is concerned, this is brim-full beyond all overflowing, and bitterness beyond all gall. Then the great habitations, especially those which an Irishman, unbreakable on the wheel of misery, calls, "The first floor down the chimbley," are not very much better. In the absence of malaria and the enjoyment of light they have some advantage; but this advantage is very small, in consequence of the great variety of temperature in the higher garret, which burns like Lybian sands in the summer, and chills like the Polar ice in the winter.

If these displays were made only in old houses which have been left as heritage for a series of generations, there might be at least a shadow of excuse for the cruelty thus displayed. They are not, however, confined to those old and rickety places; and, indeed, such places do not, perhaps, contain the worst part of the abomination—they certainly do not display the most heartless examples of it. There are in the present day wretches who live in splendour, fare sumptuously, pray to the God of all goodness, and call him their Father, and who yet deal in this depth of human misery, as a regular and by no means unprofitable trade: demons of this description are not rare; and they pursue their vocation as if it were one of the most honourable upon earth. One of them takes a lease of a piece of ground in some frowsey corner, and covers it over as thickly as he can run them together, with hovels which are absolutely unfit for the habitation of pigs, and through which the wind howls in every blast, the sky weeps in every shower; and when the frost

bites in its keenness, hailstones dance on the floor as thick as locusts: such hovels are let by the week, and-rent day comes round every Monday. Then may be seen the monster squeezing the last farthings out of the sick and the destitute, all reckless of the misery he may occasion. He takes the lead, strutting onward in his pride, and followed by his broker's cart, collecting its load of old brooms, broken chairs, sleeveless coats, and legless breeches; and into this he collects, of strange materials certainly, that wealth which is the element of his glory, and enables him to hold his head on high. But the picture is too much even for the iron bowels of a journalist, and so we turn from it in disgust.

By way of illustration to this article we have appended sections of the walls from a first-rate to a fourth-rate house inclusive; and though these are mere sketches, they will give a tolerably correct idea of what is meant. The cross dotted lines in the fourth-class houses, show the alterations which have been made in the new plan.

[Since writing the above sentences, the Bill alluded to has been withdrawn, on the suggestion of the Speaker of the House of Commons, as it contained matters inconsistent with the privileges of that House, and Mr. Fox Maule has obtained permission to bring in an amended bill, which will be referred to a committee upstairs. Members on both sides of the House seemed to concur in admitting the vast importance of the details, and of the misery and suffering which resulted from the want of such an Act. Sir James Graham announced that a new Drainage Bill would be introduced upon the responsibility of Government.]

SCHEDULE COMPARING PROPOSED MEASURE WITH WITH THE PRESENT ACT, AS FAR AS RELATES TO WALLS.

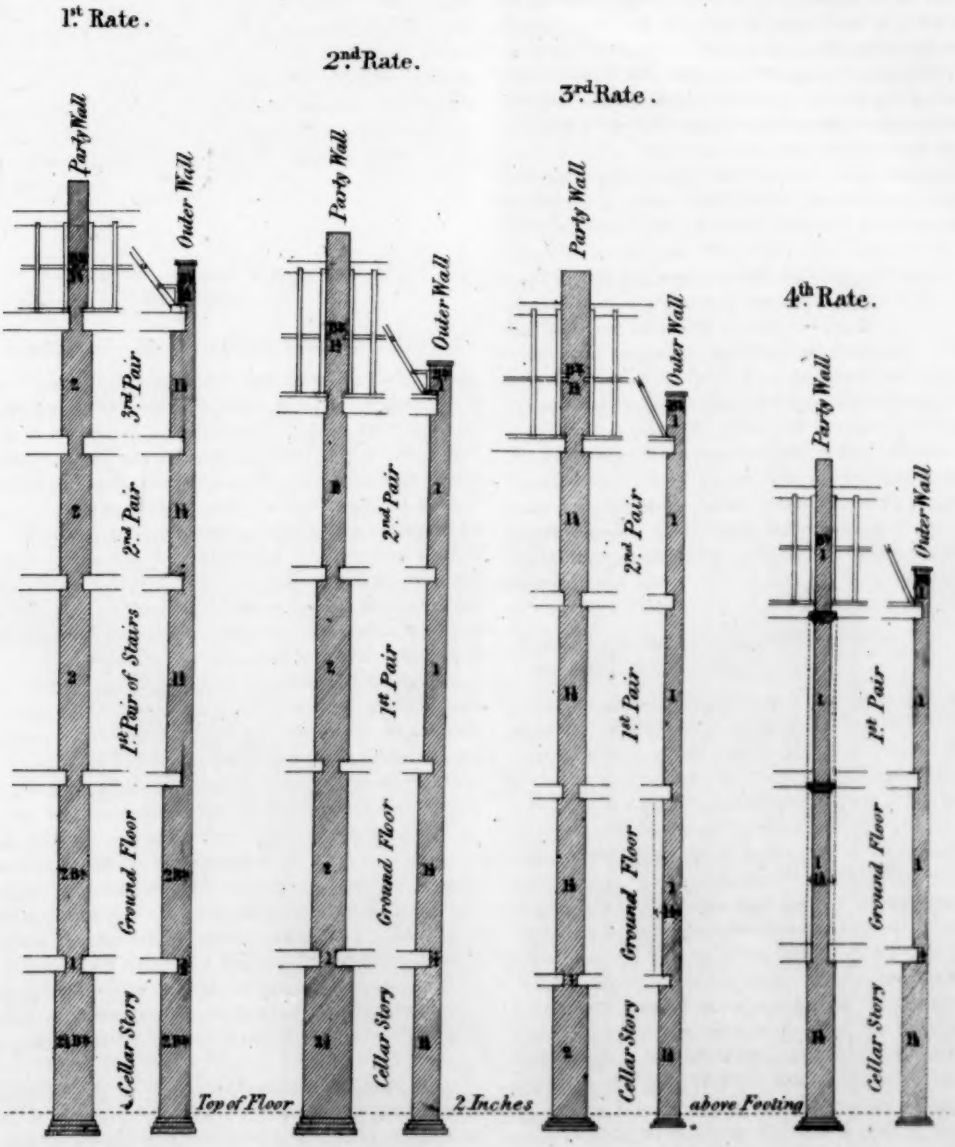
	Number of Class or Rate.	Height of Warehouse	House.	No. of Square of Building.	Thickness of Outer Walls.				Thickness of Party Walls.				
					In Cellar Story to underside of Ground Story Floor	In Ground Story to the top of Joists in Floor above Ground Floor.	Above to the top of the Wall, or if a Parapet to the upper side of the Ceiling of the top Story.	Parapet.	In Cellar Story to underside of Ground Story Floor.	In Ground Story to the top of Joists in Floor above Ground Story.	Above to the top of Joists in Floor above First Story.	Above to underside of the Ceiling of the top Story.	Above through the Roof to the top.
New Bill.	1	Higher than 31 Feet.	50 Feet or more than 3 clear Stories.	More than 9	2 Bricks or 17½ Inches.	2 Bricks or 17½ Inches.	1½ Brick or 13 Inches.	1 Brick or 8½ Inches.	2½ Bricks or 22½ Inches.	2 Bricks or 17½ Inches.	2 Bricks or 17½ Inches.	2 Bricks or 17½ Inches.	1½ Brick or 13 Inches.
Present Act.	1	Same.	Value £850 or more.	Same.	Same.	Same.	Same.	Same.	Same.	Same.	Same.	Same.	Same.
New Bill.	2	Higher than 22 Feet, or having 3 Stories.	40 Feet or 3 Stories and no more.	From 5 to 9.	1½ Brick or 13 Inches.	1½ Brick or 13 Inches.	1 Brick or 8½ Inches.	1 Brick or 8½ Inches.	2½ Bricks or 22½ Inches.	2 Bricks or 17½ Inches.	2 Bricks or 17½ Inches.	1½ Brick or 13 Inches.	1½ Brick or 13 Inches.
Present Act.	2	Same.	Above £300 and not £850.	Same.	Same.	Same.	Same.	Same.	Same.	Same.	Same.	Same.	Same.
New Bill.	3	Higher than 13 Feet or 2 Stories.	37 Feet or 3 Stories and no more.	From 3½ to 5.	1½ Brick or 13 Inches.	1½ Brick or 13 Inches.	1 Brick or 8½ Inches.	1 Brick or 8½ Inches.	2 Bricks or 17½ Inches.	1½ Brick or 13 Inches.	1½ Brick or 13 Inches.	1½ Brick or 13 Inches.	1½ Brick or 13 Inches.
Present Act.	3	Same.	£150 and not £300.	Same.	Same.	1 Brick or 8½ Inches.	Same.	Same.	Same.	Same.	Same.	Same.	Same.
New Bill.	4	Not higher than 13 Feet.	25 Feet or 2 Stories and no more.	Less than 3½.	1½ Bricks or 13 Inches.	1 Brick or 8½ Inches.	1 Brick or 8½ Inches.	1 Brick or 8½ Inches.	1½ Brick or 13 Inches.	1½ Brick or 13 Inches.	1½ Brick or 13 Inches.	1½ Brick or 13 Inches.	1 Brick or 8½ Inches.
Present Act:	4	Same.	Under the value of £150.	Same.	Same.	Same.	Same.	Same.	Same.	1 Brick or 8½ Inches.	1 Brick or 8½ Inches.	1 Brick or 8½ Inches.	Same.

SCIENTIFIC SOCIETY OF LONDON.

We attended at the new apartments of the Institution in Gray's Inn Square, on Wednesday, the 16th ult., when Mr. Moxon read a paper from Mr. James Buckman of Cheltenham, on the oolitic formation of that district, which embodied some very useful remarks as to the strata and the fossils which they contain.

The paper gave rise to a discussion on the advantages the members of professions, involving scientific principles, might derive by promoting among themselves the study of the fundamental sciences.

ILLUSTRATIONS OF BUILDINGS' REGULATION BILLS.



Note. *The difference to be observed under the proposed New Measure is shown above by the dotted lines in the third and fourth Classes.*

J. Dower lith.

Published by J. Weale, Architectural Library 59, High Holborn.

We were struck with the truth of some observations which fell from the President on the value of geological knowledge in the construction of buildings, which he exemplified by instances with which he himself was acquainted. An engineer from Philadelphia made some apt remarks on the weights which particular stones would bear in proportion to the quantity of crystalized matter in them; and he was followed by observations from other members on the influence of subsoils on the productive qualities of surface-soils. These observations, all bearing on those professions to which we dedicate this work, produced in us the reflection that there was yet much to be attained, and it would be well for all those who desire to improve themselves in their profession, to obtain, if possible, access to the meetings of this society.

REVIEWS.

Use of the Spirit Level. By T. O. Blackett, Surveyor, Newcastle.

This is not exactly a new book, any more than Euclid's Elements, Euler's Algebra, or Smeaton's Reports, is a new book; but it would be most unwise to find fault with it on that account. Of the books of this day the newest are those which have the first claim upon the notice of the Reviewer, and they may have this in consequence of their merits, their demerits, or the simple fact of their being new. This is in a great measure unavoidable, especially by those who write of the day, and for the day, and are what is called very popular writers. But though necessary, this is an evil, and often a very serious one, especially to the young and inexperienced, who are thus attracted from what is really valuable to what is merely new. In all cases where it can occur this is an evil. It is so in the case of politics; for they who are engrossed by the mere sayings and doings of the day, are generally so very ignorant both of the principles and the history of society, that their opinions are not worth having. In literature, though the evil is not so serious, it is more general and glaring. Of the daily productions of the press, not one is possessed of distinguished merit; and, unlike politics, they are not required for the ordinary conversations of the day, but are confined to the idle gossips.

In consequence of this rage for novelty, the really good books are apt to be overlooked. A book must be of a certain age and standing before its value can be known; and if it bear the test of this time, it becomes a classical or standard work on its subject, a property which no merely new book can possess, on account of its novelty. This applied to new books in all ages, but never so perfectly or so generally in the case of books of all kinds as it does at present.

Mr. Blackett's Essay, as we have said, is not a new book; but on this account it is the more valuable; and we very much doubt whether a new book could or would be written answering the same purpose, and answering it so well. Writers of the present day, even when they profess to be elementary, very seldom are so in the proper sense of the word. What they write may be elementary to themselves, but it is not so as respects those who seek to learn. The writer is more intent upon showing his own learning than upon giving clear views of the elements of his subject, and therefore he is unfit for instructing the ignorant, or being useful to the student; and we think that this perversion is more inveterate in books relating to engineering and the collateral sciences and arts, than it is on any other subject whatsoever.

This Essay by Mr. Blackett avoids both the puerility and affected philosophy of the common writers of the day. It is even older in its method than in its date, and on this account it cannot fail of being more useful. It openly professes to be an Essay on the Spirit Level, and its ordinary application and use, and to this it most strictly adheres. Hence it is one of the clearest books that we ever read; and, therefore, though it would have been easy to write a more learned book on the spirit level, one more useful to the student or the ordinary practice of the surveyor could not have been written. The instrument itself, and also the staves and other matters required along with it, are so clearly explained, that nobody that reads the Essay can fail in understanding them, or, at least, if any one should thus fail, he is not only no surveyor, but incapable of becoming one. The uses of the instrument, and the various ways of using it, together with the best methods of recording the observations and planning them, are given with equal clearness; nor have we ever seen a book in which the illustrative figures were more accurately and tastefully delineated. The whole book shows that Mr. Blackett's long experience has not been lost upon himself, and that he is admirably fitted for making it useful to those by whom it is required. The book is a very simple one, but this simplicity constitutes no mean part of its usefulness; and we feel ourselves constrained to say that, upon a single subject, this is a perfect model, and a model which cannot be too generally or too closely copied. Such being the properties of the book, we cordially recommend it to all those for whose benefit it has been written.

Elementary Surveying. By Major Basil Jackson. Simpkin and Marshall. London, 1842.

Just when land surveyors, as a body of professional men, are at rather a low ebb, we have a book published which may safely be pronounced one of the most useful of its class, and one which, had it been written twenty years back, would have done much towards elevating the practice of land-surveying above the mere mechanical occupation it has gradually become. The science (for it was a science), has fallen so low in the scale of intellectual employment, that the great majority of its professors have degenerated into mere manual labourers. This may seem a strong assertion; but it is amply borne out by our own personal experience; and by that, too, we are certain, of many of the leading members of the profession.

Major Jackson calls his book "Elementary Surveying;" but we may venture to say that not one half of the vast flock of land surveyors, who have been practising under the tithe commission act, would comprehend the first 25 pages of this book, although it is written in the most easy and intelligible style. And why is this? We answer, because it has been the custom of land surveyors to teach their pupils to despise theory and reading, and to depend on field practice only. We have known surveyors in the field to be so completely confounded and perplexed in meeting with a sheet of water some few chains wide, on a long line, that they have either walked through the water themselves in desperation, or paid men to do so for them, while they have looked on enjoying the trouble their ignorance has entailed upon others, or they have done up their chains and left work for the day, determined to bring a rope long enough on the morrow to reach across the water. In some

cases, indeed, we have seen surveyors raise perpendiculars from the line impeded as nearly correct as can be done, without any method or instrument, and measure beyond the interference of the water the parallel distance. This method of surmounting the difficulty affords as near an approximation as ordinary surveyors desire, but a little geometry would relieve them from such uncertainties, as may be seen by problem 78, at page 26. Let our readers look at problems 55 and 81, and say at once if it would not have often saved them much time and trouble to have applied these problems when they wanted either to raise a perpendicular from a line, or to determine the width of a river, the marginal boundary of a parish or property. The great merit and usefulness of Major Jackson's book is this:—The actual measurement of land by the chain, in the manner taught by our men of business, is a matter so easily attained, that a few months of cart-horse labour will render any one of ordinary mind a perfect master of it. Now, this section of surveying is hardly touched by the author, and the little he does say about it, proves that he has not practised it in the plodding and systematic way of professional men; he states, at page 41, that the chain leader and follower, when they "face about" and "set down," are to hold the chain with both hands, showing at once that Major Jackson, though an excellent preceptor, has not been gaining his livelihood on surveys of parishes at 6*d*. or 9*d*. an acre! but no man can read many pages of his treatise without being satisfied that what is wanting in the education of surveyors may be found in it, and he would likewise be assured, that the plodding mechanical process followed in parish surveying, might have been relieved of dulness and monotony by the occasional introduction and practice of such problems and hints as are here set forth. What are surveyors for the future to do? is a question we are often asked. Let them look to the colonies—to India, America, and Australia, but to India more particularly than to the other colonies. The East India Company are indeed a host in themselves, and we may be satisfied that it will not be long ere railways and other national works will be taken up by them under the conviction of their necessity. There is the proposed railway from Delhi to Calcutta, which is to traverse a distance of 1200 miles, over a country well calculated to call forth the talents and energies of surveyors: then, again, there is the much talked-of canal across the isthmus of Panama or Darien, which, if carried into effect, would bring New Holland 8000 miles nearer, and lead to an immense increase of trade with the islands of the Pacific; but these and such like projects are of too excitable a nature for our matter-of-fact hedge-and-ditch gentlemen, who would find it as difficult to solve the letters Q. E. D., as to define a rhombus or dodecagon; yet, if land surveyors are to continue to get a living by their calling, they must study these things, or they will stand no chance with military surveyors and engineers, who would, in their turn, be puzzled in the complication of details of parochial surveys. Major Jackson's book is just the one, we repeat, which we would recommend to our friends of the chain as an easy introduction to trigonometrical knowledge, and we shall turn to it again, and elucidate its merits by giving instances and examples, in which the various problems *might* (for such things are the bye-gones of past times) have been advantageously used in surveys for inclosures and parish purposes, and of private estates. As there has been some talk lately of relief-mapping, we extract the following ingenious hints for the perusal of such as are interested in this art:—

"Mr. Barr, the professor of military surveying at Sandhurst, showed me recently what I think a very ingenious and striking way of conveying a just idea of this style, by means of a model in plaster of Paris, representing some hilly ground. He had enclosed his model in a wooden box, which was then filled with water. A scale, divided into quarters of an inch, having been placed upright in the box, the water was allowed to run off through a hole near the bottom, by a quarter of an inch at a time, as indicated by this scale. At every successive fall of the water, he traced lines on the model, indicating the curves shown upon its surface by the successive lowering of the water. When the operation was completed, the surface of his model exhibited a number of lines, all of course perfectly horizontal; closing upon each other where the hills were steep, and diverging again where the slopes became more gentle."

SHORT NOTES.

RAILWAY ACCIDENTS.

THE blue book containing the report on railway accidents, is under consideration, but could not be got ready in time for the present month. It appears that twenty-eight individuals were killed, and thirty-six injured, by accidents during the year 1841.

CORPS OF ROYAL ENGINEERS.

THE fifth vol. of the professional papers of this most respectable corps lies on our table, and we have just time this month to look at the plates, which are very good, and at the contents, which are very promising; but we shall pay all due attention to it next month.

LONDON IMPROVEMENT SOCIETY.

BY next month we hope to be able to give a circumstantial account of the proceedings of this society, which we understand are of the most interesting character, and cannot fail in being both ornamental and useful to our mighty metropolis.

LECTURES ON CIVIL ENGINEERING, WITH PRACTICAL ILLUSTRATIONS.

BY PROFESSOR VIGNOLES, C.E.

(*From the Mining Journal.*)

ON Wednesday, the 9th Feb., Professor Vignoles delivered his Introductory Lecture to the second course of lectures "On Civil Engineering." He stated that having, in his first course of lectures, touched upon several of what he might call the cardinal points of civil engineering, he was then about to enter the second course, for which (according to previously concerted arragements) one only of the numerous branches of this profession had been selected as the theme, with a view of entering considerably into its details, rather than to discuss, in a more general manner, a variety of subjects, which, though, perhaps, equally important, equally interesting and useful, and equally necessary for the student, could not be thoroughly investigated in the course of a single session. In this introductory lecture, he would, however, touch concisely on the wide topic of the internal communications of civilised countries, as falling within the scope of the theories and practice of a civil engineer, treating them here as on a general theme; but the subsequent discourses to the class would consist of the details of that more modern branch of internal communication, of so much interest in the present day—the Railway System. It had been well and truly remarked, by an enlightened observer, that the great characteristic feature of the present age, was the appreciation of the value of time. In an eloquent introduction to a pamphlet, on one branch of internal communication, the author expressed himself in terms which he was tempted to quote, as an appropriate preliminary to his own remarks:—"In that career of improvement which has distinguished the last thirty years beyond, perhaps, any previous history of the world, and in which the sum of the vast ameliorations effected, in all that relates to the

condition of man, is not less striking than the rapidity with which their details have followed upon each other; one important lesson seems to have been in an especial degree impressed upon those engaged in the pursuits of industry, and upon the commercial and manufacturing classes in particular—they have been effectually taught to appreciate the value of time, and to apply to its use a degree of rigid and judicious economy, of which the past affords no example—a lesson which is daily illustrated by the vast expenditure, in this country, upon works affording facilities in accelerating intercourse, since it is universally felt that distances are virtually shortened in the precise ratio in which the time occupied in travelling them is abridged." And it is the practical application of this axiom, which it is almost peculiarly the lot of the civil engineer to be called on by the statesman and the capitalist to realise. In looking back through the vista of centuries, and endeavouring to pierce the mist of tradition, we are led to conclude that the formation of roads must have been amongst the earliest rudiments of civilization; but, until science, or at least until system, was applied to their construction, it is evident (from the traces of the simple paths of comparatively modern times, and of no remote countries) that the merest tracks sufficed to satisfy our ancestors, who had not yet learned the "value of time." Little more was then required than a path upon naturally firm earth; all marshy grounds were avoided; the fords of the rivers were alone resorted to; and the irregularities of surface, or inclination of the road, or its circuitous course, were of little consequence to the pedestrian, or even to the mounted traveller, when man had learned to subdue the horse to his wants and wishes. The path generally traced from one distant wigwam to another, became the track from village to village, and at length served as the road from town to town, or even to the capital; the line once traced out, indolence and habit seem to have prevented any great exertion to improve or repair, beyond what was indispensably necessary, even after the invention of wheeled carriages; and the system of following the ancient course seems of roads to have been pertinaciously adhered to in all countries, until the advance of civilization, and the wants of the community, produced improvement, and gave rise to the calling of the roadmaker, and ultimately to the profession of the engineer. The first exercise of his art—for it did not reach the dignity of a science until within very modern times—was, probably, in the formation of raised roads, or causeways, to strong-holds, dwellings, or cities, accidentally or artificially made liable to inundations; and of this kind were the approaches to the passage of the River of Babylon, which the fables of antiquity magnified into a bridge, as long, and consisting of as many arches, as that in the celebrated vision of the Arabian sage. The first step towards internal communications being roads, it may be well defined as the first step in true civilization, and the Abbé Reynal has justly remarked, "Let us travel over all the countries of the earth, and wherever we shall find no facility of trading, from a city to a town, and from a village to a hamlet, we may pronounce the people to be barbarians, and we shall only be deceived respecting the degree of barbarism."

By this test we should probably be induced to judge of the Chinese, if their water communications did not, to a certain extent, supply the absolute want of anything like a road capable of passing a loaded wheeled carriage, even at the gates of Pekin. Of all the people in the world, perhaps the Romans took the most pains in forming their roads, and vast was the labour and expense bestowed to make them spacious, firm, solid, and smooth—roads, in fact, from two to even ten or twelve feet thick, formed of what we call in these days "concrete;" but, as regards the system of laying out, in the modern engineering sense, they do not appear to have had the slightest idea. Straightness of direction seems to have been their only character, and, with a lofty disdain of the effects of gravity, their grand military routes, except near Rome itself, were carried direct over hill and dale. Thirty roads, of an aggregate length of 50,000 miles, radiated from their magnificent capital, in Italy, to the farthest extremity of their almost boundless empire; they only served as internal communications, for keeping down, by their legions, the rebellious spirits of the Briton, the Hun, the Greek, or the Persian, who had, in succession, bowed to the Roman yoke; yet, as monuments of the highest degree of art and civilization of those ages, must they be admired by all, and may be usefully studied by the engineer of the present day, few of whose constructions, even the gigantic railway, will probably endure as some of the Roman roads have done, such as the Appian Way, for instance, through the long period of nearly 2000 years. The number and extent of these roads, made by the first conquerors of Albion, through this island, have only been ascertained and appreciated since the publication of the magnificent maps of the Ordnance Survey, by the corps of Royal Engineers, by those who have studied their beautiful and surprising accuracy, and their minute topographical details, which enable a curious inquirer to trace, by their remarkable straightness of course, these ancient routes, through woods and remote districts, and over wide ranges of hills, where their origin, even in tradition, is now forgotten, and where the long lane, grassed over and forsaken, from its steepness or seclusion, accurately laid down, in its true course, by the science of the present day, marks, at intervals, over whole counties, the former line of the stately march of the Roman soldier. But it remains to this day an unsolved problem in engineering, to discover by what means these roads were laid out in such perfect truth of direction, through the thick and trackless forests which then covered the whole island. It has been observed, that it is one of the most difficult points for a political economist to define, with any degree of certainty, the line of demarcation between public and private enterprise, in the execution of works of internal improvement. In a former lecture, he observed that it was undoubtedly owing to the establishment in France, by Richelieu, of the Board of Roads and Bridges, that that country was in possession of excellent roads long before the principal part of Europe; he might have added, also, canals—at least, before we had them in Great Britain, and yet have a good reason to believe, that, at the present time, that very establishment is a serious obstacle in retarding the introduction into France of the modern system of improvement of internal communications, by paralysing the self-dependence of the districts. In this country, the very opposite system of leaving almost everything to private enterprise and individual exertion, has been most strikingly successful, and has fostered and matured the talent, the ingenuity, the skill, and the experience, of the civil engineer, from the competition created by the necessity of individual exertion, which it is presumed would not have been developed, had he been a Government dependent. The origin of the system of forming and repairing roads by trustees, and the collection of tolls for that purpose, at turnpike-gates, dates somewhat more than a century back, and the rapid improvement of our internal communications, both by land and water, about that time; and it is a remarkable fact, that, when land was of comparatively small value, it was more difficult to obtain ground for a new road than at present, when a square yard of land sometimes costs more than would have purchased a rood in former days; and when one of the public objections seriously urged was, that if so many roads and canals were made, it would diminish the quantity of land required for agricultural purposes! But, happily, general knowledge has been diffused, and the former prejudices have yielded to calculation, as man has acquired a knowledge of the value of time, and has found that the payment of turnpike tolls, for good and level roads, is cheaper than to keep extra horses to drag his teams up steep hills, or through marshy ruts. The Professor next stated, that he should not go into the detail, either of the laying out or the construction of roads, but he must add a few observations, as connected with the duties of an engineer, in regard to some of the general principles. He should accommodate a new line of road to local circumstances, so far as could be without superseding public advantages. It would be ridiculous to follow the old Roman fashion, on the mathematical axiom that a straight line is the shortest that can be drawn between two points. This would not make the most commodious road—hills must be avoided, towns must be resorted to, and the sudden bends of rivers must be shunned. It is not suggested that roads should be made serpentine merely for the sake of the picturesque, but the skill of the engineer is to be exerted in avoiding irregularities of ground, and irregularity of inclinations; and he will generally find, that a strict adherence to a straight line is of much less consequence than is usually supposed, even in actual distance over long lengths. It was well known that a blind man was, some years ago, advantageously employed, through Yorkshire and Derbyshire, in laying out roads through those hilly counties. He followed the streams which made their way amongst the hills, and, by finding out the chords of such arcs, or bends of the river, as passed on practicable ground, he succeeded in his attempts. It is obvious that, when the arc described by a road going over a hill is greater than that described by going round it, the circuit is preferable; but it is not known to the ordinary road surveyor, though it ought to be ingrafted in the mind of the engineering student, that, within certain limits, it would be less laborious to go round the hill, though the circuit be much greater than that which would be made in crossing it. Thus, when a hill has an ascent of no more than one foot in thirty, the thirtieth part of the whole weight of the carriage, of the load, and of the horses, must be lifted up whilst they advance thirty feet. In doing this, one thirtieth part of the whole load continually resists the horses' draught, and thus, in drawing a waggon of six tons weight, a power to overcome resistance equal to the force of two additional horses must be exerted. But what is here said of level roads, must not be strained into an assertion that a perfectly level road is always the best for every description of draught or load; alternations of rising and level, or of falling ground, are serviceable to horses moving very swiftly; the horse has time to rest his lungs and different muscles, and of this the experienced driver knows how to take advantage; but while this qualification is made, care must be taken not to strain it too much, as did one provincial road-maker, who very ingeniously carved a naturally quite level road into a series of short billowy undulations, which his successor had

to level again. Without travelling through the whole history of road improvements, he might state that Telford, in England and Scotland, and in Ireland, Nimmo, Griffiths, and Edgeworth, brought the laying out and construction of roads to the present perfection, and, of the writings of the latter, he had availed himself in many of the preceding observations. The many roads of Great Britain were just arrived at almost the highest degree of perfection, when again the increased appreciation of the value of time led speculators to conceive, and our engineers to realise, the idea of the employment of iron surfaces for roads. Before, however, following the gradual transit of roads into railways, he would make a few observations on the other branch of international communication—the navigable river and the canal.

The tastes and speculations of the last fifteen years have been so exclusively devoted to railways, as the fashionable mode of internal communication, that canals have almost been lost sight of, and it is now nearly forgotten by the modern speculator, though it may be interesting to the young engineer to be informed, that, fifty years ago, the mania for constructing canals and improving river navigation, was as great, even if not greater, than the enthusiasm displayed very recently about railways; Parliament was then deluged with applications to grant Acts of Incorporation for canal companies; the press teemed with canal publications; the shop windows were filled with canal maps and sections, and the papers and periodicals with advertisements and paragraphs on canalisation. Canals appear to have been duly appreciated in ancient times, and used for the purpose of drainage, irrigation, supply of water, and navigation. In his former introductory lecture, he alluded to the canal of Xerxes, at the foot of Mount Athos—an attempt which is stated to have been renewed by the Roman emperors in later ages. A canal, navigable for large boats, was constructed by the Ptolemies between the Nile and the Red Sea, though it is doubtful whether the state of engineering skill in those days permitted an actual junction to be made; this grand navigation was re-opened by the caliphs in the seventh century. Traces of it are still existing; and its termination in the most easterly branch of the Nile, was discovered by M. Boutier, in 1707, and is still open. Under the enterprise of the present ruler of Egypt, it may yet fall to the lot of an English engineer to re-open this magnificent canal. Herodotus assures us that the Nile was in itself, or by lateral canals, navigable by the ancient Egyptians for 500 miles above Alexandria, and the Delta of the Nile was formerly like modern Holland, filled with canals. The Romans made more than one canal in England; the most remarkable was that called the Caerdyke, which united the river Nene, a little below Peterborough, with the river Witham, three miles below Tiverton: it was forty miles long, and fifty years since appeared distinct enough, and must have been originally very deep; and what led to the impression that this canal was used for the purpose of internal communication, was, that there was a continuation of this canal from Lincoln to the Trent above Gainsborough, by the Foss Dyke, which is at the present time a fine navigable canal, though, in former times, it had been repeatedly filled up, and gone into disuse. It is believed, on good authority, that by these two canals the favourite colony of the Romans at York received their chief supplies of grain. The canals of China have always excited great interest since the description given of them by the Jesuit missionaries; their accounts, as far as regards the Great Canal running from north to south (connecting, except at one short portage, Canton and Pekin), have been completely confirmed by modern travellers, particularly by Barrow, who travelled the whole length. Should the existence of the numerous lateral and other canals over the rest of the country be confirmed, of which there is little reason to doubt, it will sufficiently explain the non-existence of anything like good roads, and the almost total absence of wheeled carriages for goods, to which the diminutive and bad breed of horses in China no doubt contributes. There is, however, a wide field opening in that country for the exercise of the skill of an enterprising engineer, since that ingenious people are as yet ignorant of the modern lock for their canals, and when two canals meet, the difference of the level is sometimes from fifteen to twenty feet, and the boats are hoisted from the lower canal up an inclined plane of smooth masonry, by capstans, and slide down another into the upper canal. The Professor stated it would lead him too far to go much into the history of canals, but he must allude to the great canals and inland water communication of the Mogul country, in the East Indies, made by their Emperors 500 or 600 years since, for which the natural features and vast rivers of Hindostan afforded great facilities, and rendered lockage unnecessary, and, indeed, roads were unknown, and may be considered as still wanting all over India, excepting our recent military roads. This country presents a vast field for the civil engineer. Of all the canals of modern Europe, he would only notice two remarkable instances; J. Perry, an English civil engineer, was employed by Peter the Great in the beginning of the last century, to design and execute several canals, in which the German military engineer, (Brockel,) who had attempted them, had entirely failed; Perry's designs were subsequently completed by Peter's successors. The canal of Trolhatta, in Sweden, the difficulties of which had long baffled the engineers of that country, was finally completed by the skill of the late Mr. Telford, whose engineering resources were equally displayed in the design and execution of the Caledonian Canal. Many remarkable instances of success in making an imperfect river into a good navigable stream, might be quoted, both in Europe and North America, and which presents instructive instances to the young engineer. The improvement of the river Liffey, at Dublin, and the river Clyde, in Scotland, are good examples. The improvement of that vast inland gulph, the Shannon, is now in the course of execution, after several years of most detailed and elaborate inquiries, estimates, surveys, and careful examination, the accounts of which may be studied with great advantage to both the experienced and young engineer. Upwards of half a million sterling is to be expended on this truly national undertaking. The learned Professor then entered into a long account of the probable original ideas for the application of iron to roads, commencing with the wooden railways used in the collieries on the banks of the Tyne, near Newcastle, above 200 years ago; he then showed that the waste of timber led to the idea of covering wood with plates of iron, and ultimately to the present point of perfection—wrought iron rails, the introduction of which into general use does not extend further back than thirty years.

In the ensuing lectures he should endeavour to illustrate the following points—1st. The principles on which railways should be laid out under various circumstances of traffic, and topographical feature. 2nd. The comparison of different systems of inclinations or gradients. 3rd. The analysis of the advantages of various breadths or gauges. 4th. The illustration of the different modes of forming the railway proper, or upper works. 5th. The investigation and explanation of the great works of construction, as peculiarly found expedient in forming railways. 6th. The practice of framing estimates, and the necessary details connected therewith. 7th. The consideration of the various modes of working railways by animal and by mechanical power, locomotive and stationary. 8th. The inquiry into the working expenses and annual charge on railways; and concluding with a summary lecture, in which the general features of the course will be given, and drawing such prominent inferences as might be most useful and interesting. The other branches of internal communication, as well as the various and numerous subjects connected with the theory and practice of a civil engineer, must be taken up on other occasions. Reserving, then, the elucidation of the details under the several preceding heads for the Class Room, he would proceed to make a few general remarks. Of these, the most prominent and most important, in his judgment, and most to be impressed upon the mind of those about to enter the profession of a civil engineer, was that connected with the great excess of actual expenditure in the construction of railways over estimates, for not only has that unfortunate and almost invariable occurrence brought discredit on each concern so affected, but it has paralysed, and will long continue to paralyse, the most honest and well-grounded schemes for further internal communication in general, and of all improvements, the cost of which is dependent on the engineer; and though each case ought to be tried and judged on its own merits, the public confidence appears gone, and the capitalist observes with a sneer, "You engineers are all alike; we can trust none of you." Now, without shrinking from his own individual share of the odium thus cast upon the profession, as far as it may truly be deserved, the Professor denied the general and sweeping imputation, and he called on the directors of public companies, in justice to themselves, to their subscribers, to their own engineers, and to the public in general, to publish such details as would exonerate his profession, and leave it charged with no more than what was attributable to it. He called upon his brother engineers to follow this out, by furnishing their quota of information. Let the public in general know these details as matters of railway statistics of the highest interest—let the profession know them as matters of precedent of thé most valuable kind—and let the capitalist be undeceived as to his present impressions of mistrust. Quite independent of any financial difficulties—quite independent of any standing orders or regulations of Parliament—a man might as well cry "mad dog" as talk of a new railway speculation, or a water-work, or, indeed, any public undertaking, where the function of profits is a certain known quantity, but dependent on estimates which are considered visionary, because "all engineers are alike in this respect." Let, then, the young engineer mark well the bitter lesson the oldest engineers are now learning—let them cause the most assiduous inquiry into the details—the most unremitting toil in gathering information—storing their minds, exercising their memories, practising their hand, and working out their calculations—let them remember that by working drawings, by models, and by every *à priori* means of unceasing investigation, they must "first and truly calculate the cost" of what in future life they may be called upon to undertake. If the matter be ever so trifling, they must not shrink

from the truth, or attempt to disguise it from themselves, still less from their employers. Let them never have it said of them that they had whispered among themselves, "Oh! it will never do to tell the directors what the work will cost, or it will never be entered upon"—a remark which he had heard fall from an eminent engineer; nor let them indulge in the vain hope of future fame by taking as their text the observation attributed to another engineer of the very highest, and well-deserved, reputation—"A century hence there will be no one who will ask what this work cost, they will only inquire who did it."

He begged to repeat then what he stated at his first introductory lecture, that the constant maxim the young, as well as the old, engineer should keep before him is—"That the success of an engineer in this country of private enterprises and individual exertions, depends not upon the beauty or the cost of his constructions, or as mere works of art, but on their success as profitable and mercantile speculations." They must not suppose this to be an ignoble maxim; it must be followed out to its true results, and then they would find that prudence, caution, economy, judgment, and the highest intellectual gratification follow closely in its train; for, to apply the words of Mr. Booth, the intelligent secretary of the Liverpool and Manchester Railway, and one of the fathers of the modern railway system—"The contemplation of what is passing in England (alluding to the first cost of railways) must not be without its lesson, for, in all countries, and under all circumstances, it is an object worthy of a statesman, to prevent the reckless waste of the national means, and to give a right direction to the public expenditure." And shall it be said that it is not equally worthy of an engineer? What are the aggregate subscriptions of associated and incorporated bodies of individuals but great portions of the "national means," which should not be wasted by the statesman or by the engineer? What are the monies invested in railways but a part, and, in the United Kingdom, a most important part, of the "public expenditure?" And is it not at once the duty, as it ought to be the pride, of an engineer to give that expenditure a "right direction?" Let the maxim he had laid down be duly followed out, and that duty would be accomplished. The learned Professor continued, by stating that, even at the risk of having motives attributed, which he should be unworthy of public or private estimation if he entertained for a moment, he would call the attention of the student to an instance of great expenditure on railways. The perfect completion in the manner contemplated of the internal communication by railway from London to the Sussex coast, a distance of little more than fifty miles, will amount, in the aggregate, to nearly four millions sterling. Is not that a reckless waste of the national means? Is that a right direction of public expenditure? Will not the public, in some way or other, pay for that?—the subscriber, or the traveller, or both? To quote the words of an intelligent and experienced railwayman—"With such results before us, would it not be almost criminal not to endeavour to secure the advantages of a better system?" The average cost of the railways in England has been very nearly £30,000 per mile. The cost of future lines must not be more than one-half of that sum, or it may be considered that there is an end to the extension of the railway system. The Professor stated that it would be his attempt to explain, in the course of his lectures, his ideas, that such a reduction in the expense might easily be made, and he would show that they were founded upon practical experience. The profession would be greatly aided, and the public vastly benefited, if the railway companies and their engineers would publish the detailed accounts he had asked for, to serve as a beacon, for which all would be very grateful; and it was his deliberate opinion and recommendation, that if they would not do so, Parliament ought to give the railway department of the Board of Trade powers to enforce such returns.

The total amount of capital invested in the railway speculations of this country, is probably little short of £50,000,000, and the total extent of lines about 1700 miles—most of which are now completed. This may be said to be the creation of the last fifteen years. The total length of navigable canals in Great Britain is nearly 2500 miles; they were chiefly formed in the last 40 years of the preceding century. The capital invested in this branch was about £20,000,000, with an annual expense of about £50 per mile. In addition to canals, there are about 1500 miles of navigable rivers. The turnpike roads of England and Wales are stated in official returns, to be nearly 20,000 miles in extent, executed at an expense of at least £20,000,000, and maintained at an expense of about £1,750,000 per annum, and all formed within little more than a century, exclusive of other highways, in length about 100,000 miles, with an annual expense of £12 or £13 per mile, or £75 per mile for maintenance. The extent of executed railways in the United States of America appear to be about 4000 miles, executed within the last fifteen years, at a cost of about £8,000,000, or about £5000 per mile; most of them are single lines, and it is stated that the average net income has been about 5 per cent. per annum. The extent of railways in Belgium is now about 200 miles, executed at a cost of rather more than £1,500,000, or about £8000 per mile; most of these are single lines, and have all been executed within the last ten years.

The average annual expense of maintaining the railways of England (exclusive, of course, of moving-power, carrying and managing establishments, &c.) appears to be from £200 to £300 per mile, per double way; but on the Dublin and Kingstown Railway, where the system of longitudinal timbers for the upper works has been completely carried out, the same heads of expense are now reduced to less than £50 per mile per annum, with a locomotive traffic over that railway as great, if not greater, than over any line in Great Britain. The average expense of the canal maintenance in this country seems to be £50 per mile per annum.

The Professor concluded, by stating that he would close his somewhat desultory discourse, by calling attention to the fact, that the first elements of the amelioration of internal improvements, he would not say internal communication, which arose in this country, date from the period of the introduction of the Poor Laws into England, the effect of which has been to compel the rich to find employment for the poor, or to support them, and thus has been carried out the great principle of self-dependence, in separate districts, to work out their own improvements. Certain it is, that, from the passing of the Act of Elizabeth, which instituted a legal maintenance for the destitute, and, by making mendicity a crime, swept the hordes of beggars, idlers, and sorners from the face of the land, this country took a start, and, overtaking in improvement the other states of Europe, then far in advance of her, has since pursued that successful and continued march of amendment of her internal communication, which form so remarkable a feature of England, proving her wisdom and proclaiming her prosperity. He begged that, with his previous cautions, the students would remember that the agent for the carrying out of such improvements, past and to come, has been, and he trusted long would continue to be, the civil engineer.

INSTITUTION OF CIVIL ENGINEERS.

COMMUNICATIONS.

On the Circumstances under which the Explosions of Steam Boilers generally occur, and on the Means of preventing them. By Dr. Schafhaeutl, *of Munich, Assoc. Inst. C. E.*

In this communication it is assumed, that perhaps not one-tenth of the recorded explosions of steam boilers can be correctly attributed to the overloading of the safety valve, or to the accumulation of too great a quantity of steam in the boiler. The author alludes to the degree of pressure which hollow vessels, even of glass, are capable of sustaining, if the pressure be applied gradually. He found, in repeating the experiments of Cagniard de la Tour, subjecting glass tubes of one or two inches in length, one-fourth part filled with water, hermetically sealed, and immersed in a bath of melted zinc, that they apparently sustained the immense pressure of four hundred atmospheres, without bursting; but if the end of an iron rod was slightly pressed against the extremity of the tube, and the rod caused to vibrate longitudinally by rubbing it with a leather glove covered with resin, the tube was invariably shattered to pieces.

Hence he concludes, that something more than the simple excess of pressure of steam in the boiler is necessary to cause an explosion, and that a slight vibratory motion alone, communicated suddenly, or at intervals, to the boiler itself, might cause an explosion. From the circumstance of safety valves having been generally found inefficient, he concludes that a force has operated at the instant it was generated in tearing the bottom or sides of the boiler, before it could act upon the safety valve.

From the sudden effect of this force, explosions have been ascribed to the presence of hydrogen, generated by the decomposition of water: but independently of the difficulty of generating a large quantity of hydrogen in such a manner, it could neither burn nor explode without the presence of a certain quantity of free oxygen, or atmospheric air: and such an explosive mixture would not take fire, even if mixed with 0·7 of its own volume of steam.

The ordinary mode of converting water into steam is by successively adding small portions of caloric to a relatively large body of liquid; but if the operation was reversed, and all the heat imparted to a given quantity of water in one unit of time, an explosive force would be developed at the same moment. For example, if a bar of iron be heated until it is coated

with liquid slag, and is then laid upon a globule of water on an anvil, and struck with a hammer, the liquid slag communicates its caloric instantly to the water, becoming solid at the same time that the water is converted into vapour with a loud report. A similar occurrence may take place in a steam boiler when a quantity of water is thrown into contact with an overheated plate, either by a motion of the vessel, or from a portion of incrustation formed on the bottom or sides becoming loosened. A sudden opening of the safety valve may, under certain circumstances, prove dangerous, or even any rapid increase of heat which would cause a violent excess of ebullition in the water.

An examination is then entered into of the respective powers of water and of steam, to transmit undulatory motion, and of their compressibility. According to Laplace, the conducting power of steam at our atmosphere and 294·1° Far. is 1041·34511 feet per second, and that of water 6036·88 feet. The ratio of these different velocities is therefore as 1 : 4·5.

In cases of a sudden explosive development of steam, the principal action is directed against the bottom or the sides of the boiler, whence spreading itself through the water, it is finally transmitted through the steam to the safety valve: a wave created by an explosion, even at the surface of the water, would reach the bottom or the sides of the boiler, 4½ times sooner than it would affect the top of the steam chamber; but if it took place at the bottom, the time for the explosive wave to reach the safety valve would be the sum instead of the difference of both velocities. Although these relative periods of time may be considered as infinitely small, it is contended that there is sufficient delay (counting from the moment at which the plates begin to yield) to cause the rupture of the material which would otherwise have yielded by its own elasticity had the time been greater, as all communication of motion is dependent only on time.

To illustrate the effect of the sudden development of an explosive force upon the plates of a boiler, the author gives the results of a series of experiments made by him upon iron wires, for the purpose of ascertaining the amount of elongation which took place before yielding under the sudden application of a given weight. The result was, that a wire which had resisted a tension of 22 cwt. when gradually applied, broke invariably, without any elongation, when the same force was suddenly applied by a falling body.

Similar experiments with railway bars showed that fibrous iron, which supported a gradual tension, broke by the sudden application of the same force; while close-grained iron, which was incapable of resisting the gradual strain, bore perfectly well that of sudden impact. These facts are worthy of consideration in the selection of iron for boiler plates, where the sudden action of the rending force is to be guarded against.

The details are then given of a series of experiments, illustrating in an ingenious model, by means of an explosive mixture of chlorate of potassa, the effects of explosions at different heights within a boiler.

A careful examination of the circumstances, and the results of his experiments, convinced the author that a simple mechanical arrangement, applicable to all boilers, might be introduced, so as to diminish the danger arising from the sudden development of an explosive force. He proposes to connect with the bottom of the boiler, by means of a pipe, an extra safety valve of a given area, loaded to five-sixths of the absolute cohesive force of the boiler plate. In the event of a sudden development of steam, the first shock would act upon the valve and open it, which would have the effect of depriving the wave generated of its destructive force, and at the same time diminish the violence of the second shock from the top of the boiler, having permitted the escape of a portion of the water from the boiler.

The apparatus for conducting the experiments was presented with the communication.

Mr. Parkes stated, that he had been occupied for several years in collecting facts illustrative of the phenomena of steam boiler explosions. These disasters could not all be referred to one cause. A boiler might be too weak to sustain the pressure within it, and a rupture would be the necessary consequence. But though the simple elastic force of the steam might thus occasionally account for the rending of a boiler, that cause was insufficient to explain many well-known phenomena, such as the projection of an entire boiler from its seat, the separation of a boiler into two parts, the one remaining quiescent, the other being driven to a great distance, &c. He was of opinion that a very sudden development of force could alone have produced such effects.

Dr. Schafhaeutl had ingeniously shown that an explosive force generated under water would act upon the bottom of the boiler and burst it, before the safety valve could relieve the pressure. The Doctor deduced from Mr. Parkes' theory of "the percussive action of steam," and his own experiments, that if, from any cause, such as the breaking up of a portion of crust adhering to the bottom of the boiler, a volume of steam of high elastic force was suddenly evolved, a rupture of the bottom would be the consequence, or the boiler might be separated into two parts. Mr. Parkes coincided in this opinion, and cited several examples in support of it.

It appeared to him that a force different from, and greater than, the simple pressure of the steam, was the principal agent. The Committee of the Franklin Institute, and others, who in their experiments had endeavoured to produce explosions of boilers, had very rarely succeeded, and the effects obtained fell far short of those which continually occurred by accident. It might be safely inferred from this fact, that the experimenters had not arrived at the true cause of the ruptures and projections of boilers, otherwise the production of similar effects would not have been difficult.

Describing the sudden development of a volume of steam, from highly heated plates, which no practicable number of safety valves could discharge quickly enough to save a boiler from destruction, he instanced the effects produced by the breaking up of the scale in salt pans. Carbonate and sulphate of lime were separated from brine by evaporation, and adhered very firmly to heated surfaces. A crust of salt frequently formed upon this deposit; the cessation of ebullition (if the deposit occurred over the furnace) was the consequence, and the bottom of the pan became red-hot. The manner in which the pan scale was disengaged, was to strike it with the edge of a heavy iron pricker, which allowed the brine to reach the plate; it was also frequently broken through by the expansion and bagging down of the plates, leaving the crust above like an arch. In such cases the plate was seen for an instant to be red hot, and immediately afterwards an immense column of brine was projected from the pan, the steam evidently being of high momentary elasticity. Mr. Parkes had seen a yard square of scale thus burst, the whole surface of the plate being at a glowing red heat. Had the pan been closed, like a steam boiler, he conceived that the blow of the steam on the roof, bottom, or sides, would have destroyed the vessel.

A thin copper salt pan at Mr. Parkes's Works, had a hole burst through its bottom by the sudden action of steam thus generated. The spot had no doubt been previously injured by heat. He conceived that similar phenomena might, and frequently did, occur in steam boilers.

A theory had been adopted by many writers on the explosion of steam boilers, that red-hot iron plates would generate less steam than plates at a less heat. This was founded on the experiments of Leidenfrost, Klaproth, and others, on the length of time requisite to evaporate a small globule of water in a red-hot spoon. But there was no analogy between the condition of a hot spoon containing a drop of water, and that of a body of water and heated plates in boilers.

Steam of great force would instantly be produced from a thin sheet or wave of water, passing over hot plates, the molecular attraction of a drop falling a short distance upon a plate would be destroyed, and the whole be instantly converted into steam of a high momentary elasticity. The theory of the hot spoon experiment, as applied to boilers, had been demonstrated to be fallacious by Dr. Schafhaeutl in a paper published in the *Mech. Mag.* vol. xxx. No. 799.

The explosion of several boilers had been attributed, and Mr. Parkes thought justly, to a wave of water washing over highly heated plates. He believed that the fatal accident to the "Union" steamer at Hull was so produced. The boilers of steam vessels were not at that period so well arranged as at present, for preventing the water from flowing to one side, and leaving a portion of the top of the flues dry with the fire beneath. Under such circumstances, the disaster which occurred would be inevitable, on the vessel's coming on an even keel. Mr. Parkes was not of opinion that it required the exposure of a large area of heated metal to effect the separation of a boiler and the projection of the upper half of it; as, in this case, it was the suddenness of the action, no number of safety valves could have deprived the steam of its instantaneous force, so as to have saved the boiler. The entire circumference of large boilers had been frequently divided as clean as a pair of shears would have accomplished the work. These phenomena were evidences of a force very suddenly exerted.

Sudden actions on the surfaces of boilors arose also from other causes than the heating of plates. During the inquiry into the causes of steam vessel accidents, he ascertained that, of twenty-three explosions, nineteen occurred on the instant of starting the engines, or whilst the vessels were stationary; three only whilst the engines were at work: the greatest number took place at the moment of admitting the steam upon the piston. He attributed this effect to the steam's percussive force, which would be as much felt by the boiler as by the piston; if the boiler was weak, and, distended by steam to nearly the bursting point, the shock would be sufficient to cause its rupture. Mr. Parkes then gave several instances of such occurrences.

In 1817, the boiler of a steam vessel at Norwich burst, and killed many persons. Previous to the accident, the boiler leaked in several places; the steam issued copiously from the safety valve, which was evidently very heavily loaded. The engine had scarcely made a revolution before the explosion occurred. By applying the present state of our knowledge to these facts, he felt assured that the steam's impact on the piston had been the immediate cause of that accident.

In 1826 or 1827, Mr. Parkes witnessed the effects of an explosion, a few minutes after its occurrence, in the neighbourhood of his works, near Paris. The boiler was of wrought-iron, 6 feet long, by about 2 feet 6 inches or 3 feet in diameter. By his advice the owner had previously put in a new end, formed of one piece of hammered iron, and he was strongly dissuaded from overloading his engine, or using habitually such enormous pressures. The cylinder of the engine was horizontal, and was connected with the boiler by a short pipe and cock. The proprietor informed him, that finding his machinery working too slowly, he went into the engine-house and stopped the engine. He held down the lever of the safety valve, and on turning the cock to start the engine, the explosion instantly occurred. The new end of the boiler, which was opposite to the engine, was found separated from the body, and lying in the flue. The line of rivets and a complete ring of the new end remaining upon the body, apparently little forced, and the faces of the fractured ends were as sharp and clean as if cut by a chisel or shears. The boiler, engine, and masonry, were driven into the yard in the opposite direction to the escape of the water and steam; thus, though the entire end of the boiler was removed, and the whole contents evacuated, it acted too late as a safty valve.

He observed similar effects last year in an explosion at Camden Town, being fortunately on the ground to investigate it before much change had been made. Two boilers were set end to end with a chimney between them. The end of one was blown out, and was lying close to its original seat. It was forced backwards into the chimney, which it partly supported on a pipe flange, and pushed the other boiler and entire masonry in a horizontal direction fully two feet. He considered that the percussion of the steam from its re-action against the opposite ends of the boiler in the act of tearing it off (which was the effect in this case) produced the recoil. In this case there were upon the boilers (which were connected together) two safety valves in good order, and not heavily loaded. The accident occurred during the breakfast hour, whilst the engines were not at work. One of the two stays which originally held the fractured end of the boiler, was found to have been previously broken, as its separate ends were covered with old lime scale—the other had evidently been long cracked, and was only held by a fragment. The fractured end of the boiler was not exposed to the fire, nor did the shell or the flue within it exhibit any marks of injury from fire or from dislodgement of scale. The steam, in its effort to escape, acting first against one end, not only raised the boiler from its horizontal position to an angle of about 45°, but gave it a twist obliquely from the line of its bed.

Mr. Parkes could not agree in the often expressed opinion, that what are called high-pressure steam boilers were more dangerous or more liable to explode than others. Much depended on care and management. He believed that he was in possession of accounts of nearly all the explosions which had occurred in Cornwall since the expiration of Mr. Watt's patent, when higher pressures began to be used, and they amounted only to five or six instances, exclusive of some cases of collapsed flues. More explosions had occurred in a small district round Wednesbury during the present year with low pressure boilers, than in Cornwall in forty years, where the highest pressures were employed. He believed also that the coal districts of Northumberland, Durham, and Staffordshire, would furnish more cases of these disasters from boilers both of high and low pressure, than all the rest of England put together.

When the practice in the coal districts was contrasted with that of Cornwall, the explanation was simple. Where coal was so cheap, the quantity used was unlimited, the negligence was great, and the allowance of boiler was small for any given sized engine, as enough steam could be raised by fires of greater intensity—the rule there being, to save in the first cost of the boiler; in Cornwall, on the contrary, the object was to insure economy in the consumption of fuel; consequently, all that class of accidents arising from injury to plates by fire and deposit, would be in about the ratio of the intensity of the combustion.

Notwithstanding the bad practice generally prevailing in the coal districts, there were some exceptions. At an iron work near Dudley, there were boilers now in good order after nearly thirty years' use, having required but trifling repairs during that period. In those boilers the plates of the bottoms which were exposed to the fire were all made of hammered, not of rolled iron—the boilers were large for their work, and were cleaned thoroughly every week.

Tilted plates were alone used for salt pans in those parts where the heat was most intense. Though continually heated to redness, and distorted by the action of the fire, the quality of the iron in plates thus formed did not appear to be deteriorated, for when taken out the smiths used them for making rivets, nails, &c. Rolled iron plates would do for making coarse salt, which required a heat below ebullition, but they were quickly injured when used for fine salt, and were useless when taken out.

Mr. Parkes then adverted to several other remarkable cases of explosion. It was a well-authenticated fact, that a boiler belonging to Messrs. Fercy, at Essonne in France, exploded on the instant of opening the safety valve.

Three successive reports were heard when Steele's steam-boat boilers exploded at Lyons, indicating that they did not burst at the same instant. Now, though Mr. Steele had fastened down the safety valve to increase the pressure of the steam, yet the explosion of the first boiler should, according to the received opinions, have acted as a safety valve to the second and third, and have saved them—for, by the destruction of the first boiler, the pipes would be broken, and a free exit be afforded for the steam in the others; nevertheless, they all three burst in succession. Several similar instances of successive explosions had occurred in England. He would not at present enter upon an explanation of what he considered might have occasioned these phenomena, but he would express his conviction that the practice of suddenly opening and closing the safety valves was extremely dangerous. To be useful as escape valves, they should be allowed to open and to close in obedience to the steam's pressure only, not to be handled more than was absolutely necessary.

None of the theories yet advanced appeared clearly explanatory of the cause of the projection of heavy boilers from their seats, when in many cases they contained abundance of water. He instanced a case in which a boiler exploded, and carried to some distance a boiler connected with it, and in which some men were at work. The boilers separated while in the air, and the one which exploded attained a very considerable height, although it was 28 feet long by 6 feet diameter. The particulars of this explosion were furnished to him by Mr. Clarke, engineer to the Earl of Durham, but they could not be properly appreciated or explained without the drawings and description.

A boiler weighing about 2½ tons was projected from its seat at Messrs. Henderson's Woollen Factory at Durham, in 1835; it ascended to a considerable height, and fell 300 yards from the place where it had been seated.

A cylindrical boiler exploded at the Crenver Mine in Cornwall in 1812. It passed through the boiler house, and opened itself in the yard outside, where it was described to have fallen "as flat as a piece of paper."

Facts of this nature were replete with interest, and should lead engineers to the consideration of causes and remedies.

Mr. Parkes then instanced several cases of boilers which had become red-hot, and had not exploded; one example was a set of three boilers, the tops as well as the bottoms of which were red-hot, in consequence of the house in which they were fixed being on fire; yet they did not explode. No water had, however, been pumped into the boilers whilst so heated.

He was in possession also of several curious examples of ruptures and projections of vessels arising from causes very different to the foregoing. One case occurred in February 1837, at the works of Messrs. Samuel Stocks and Son, in the Township of Heaton Norris, near Manchester. The boiler was 20 feet long, 9 feet wide, and 10 feet deep, and weighed about 8 tons. On a Saturday night the water was blown out of it through the plug-hole at the bottom, by the pressure of the steam, the man-lid not being removed. On Sunday evening the firemen proceeded to take off the man-hole cover to clean the boiler; on entering it with a candle and lanthorn, a violent explosion occurred; and the man was projected to some distance and killed. On examining the boiler it was found quite dry, no fire being alight, no traces of water near it, and it was quite cold: it had been lifted from its seat up to the roof, which it destroyed, and the walls of the building were thrown down. There was no difficulty in accounting for the presence of a combustible gas, as hydrogen might be evolved from the decomposition of steam (which would remain in the boiler after the expulsion of the water) by the heated sides and bed of the boiler, and the atmospheric air which entered through the plug-hole or through the man-hole, when the lid was removed, was sufficient to form an explosive mixture. The projection of the man was the simple effect of firing the gas; but to account for the entire boiler being carried from its seat, was more difficult. The figure of the boiler after explosion exhibited two distinct actions; the ends and sides had evidently been bulged outwards by the force of the explosion within it, and the bottom had been crushed upwards by the force which raised it from its seat.

Mr. Parkes thought the circumstances admitted of a satisfactory explanation, but would not then enter upon it, as it involved the history and phenomena of projections of vessels from their beds with a vacuum within them, which he thought would be better understood after the reading of his paper on the "Percussive Force of Steam and other Aeriform Fluids," then in preparation for the Institution.

The foregoing case of the formation of hydrogen gas in a boiler, after all the water had been evacuated, was confirmed by one which took place in a similar manner at the sugar-house of Messrs. Rhodes and Son, in London, of which all the particulars had been furnished to him by Mr. Henrickson, the manager. A man entering the boiler with a candle and lanthorn to clean it, was projected to a great height. No rupture of the boiler took place, as the quantity of hydrogen seemed to be comparatively small, and to be confined to the upper portion of the boiler, but a series of detonations occurred, like successive discharges of cannon.

These two remarkable instances showed the importance of attending to minute circumstances in the management of boilers. The practice of completely blowing out boilers whilst the flues were intensely heated, was evidently dangerous, nor should it be done without removing the man-hole cover.

Mr. Parkes felt that these notices of explosions were very imperfect without drawings, and reference to documentary evidence, but, as the subject had been brought before the Institution by Dr. Schafhaeutl, he hoped that they would be received as contributions to the stock of knowledge, and as illustrative of the precautions to be observed by attendants on steam engines.

(*To be continued.*)

MISCELLANEOUS.

Engineering and Agricultural College, Seapoint, Dublin.—We announce with satisfaction the establishment of an institution such as the above—one which is calculated to be productive of such benefits to the kingdom, in educating persons whose more immediate study will be the means of developing the still dormant, but abundant, natural resources of this country. Such an institution has long been wanting in Ireland; for the inexhaustible sources of wealth with which she abounds have been wholly neglected, save in the few instances wherein chance has unfolded them to the public consideration. We are well aware that the country contains mines of much value; but for want of properly educated master minds to commence and carry on operations upon them, they are suffered to remain untouched. Our mountains, despite their bleak barrenness, could be made to yield treasures yet but little thought of; whilst our rivers, instead of being left in all their pristine inutility, and an injury rather than otherwise to the lands upon their banks, could, by a course of systematic improvement, be constituted the natural and useful channels of the country. Those wild morasses which, to this day, Ireland is proverbial for, would, when subjected to the operations of the civil engineer, be converted from watery wastes into fertile arable plains. For the education of a class of persons capable of planning and undertaking works such as these, this college has been founded; and to keep pace in the onward course of agricultural improvement, it was necessary that a seminary should be instituted, which would enable young men to attain a knowledge of those sciences, so necessary to perfection in that peculiar branch of national industry. Such is the Engineering and Agricultural College at Seapoint; and from the high professional character of the gentlemen connected with it, and under the direction of a person of Mr. Gregory's scientific attainments, we augur the utmost success.—*Tipperary Free Press.*

LIST OF PATENTS.

Continued from page 32.

(SIX MONTHS FOR ENROLMENT.)

John James Baggaly, of Sheffield, seal engraver, for "certain improvements in combs for the hair, and which are also applicable to combing other fibrous substances."—Sealed January 29.

Joseph Hughes, of Whitehall, Mills, Chapel-le-Frith, Derby, paper maker, for "certain improvements in the method or process of manufacturing paper."—Sealed January 29.

James Hunt, of Whitehall, gent., for "improvements in the manufacture of bricks."—Sealed January 31.

Charles Wye Williams, of Liverpool, gent., for "certain improvements in the making and moulding of bricks, artificial fuel, and other substances."—Sealed January 31.

Henry Fowler Broadwood, of Great Pulteney Street, Golden Square, esq., for "an improvement in that part of a piano-forte harpsichord, or other the like instrument, commonly called the name board."—Sealed February 2.

William Newton, of Chancery Lane, engineer, for "certain improved apparatus to be adapted to lace-making machinery for the production of a novel description of elastic fabric from silk, cotton, woollen, linen, and other fibrous materials."—Sealed February 8.

Adderley Willcocks Sleigh, K.T.S., of Manchester, captain in H. M. Service, for "a certain method or certain methods of effecting and forming sheltered floating harbours of safety by the employment of certain buoyant sea barriers, applicable thereto, and which said improvements are also applicable to, and useful for, the formation of breakwaters, floating bridges, lighthouses, and beacons, the protection of pier-heads, embankments, and for other similar purposes."—Sealed February 8.

Charles Hancock, of Grovesnor Place, artist, for "certain improvements in printing cotton, silk, woollen, and other stuffs."—Sealed February 8.

Benjamin Biram, of Wentworth, Yorkshire, colliery viewer, for "certan improvements in the construction and application of rotary engines."—Sealed February 8.

Frederick Harlow, of Rotherhithe, carpenter, for "improvements in paving or covering roads and other surfaces, and in machinery for cutting the material to be used for those purposes."—Sealed February 9.

Isham Baggs, of King's Square, chemist, for "improvements in obtaining motion by means of carbonic acid, and also by a peculiar application of heated air."—Sealed February 9.

Christopher Nickels, of York Road, Lambeth, gent., for "improvements in the manufacture of plaited fabrics."—Sealed February 10.

William Brook Addison, of Bradford, manufacturer, for "certain improvements in machinery for spinning worsted and woollen yarn."—Sealed February 10.

George Jarman, of Leeds, flax and cotton spinner, Robert Cook, of Hathersage, Derby, heckle and needle manufacturer, and Joshua Wordsworth, of Leeds, aforesaid, machine maker, for "certain improvements in machinery for spinning flax, hemp, and tow."—Sealed February 14.

James Andrew, of Manchester, manufacturer, for "certain improvements in the method or process of preparing or dressing yarns or warps fer weaving."—Sealed February 15.

Charles Thomas Holcombe, of Bankside, Southwark, iron merchant, for "certain improvements in the manufacture of fuel, and in obtaining products in such manufacture."—Sealed February 15.

John Osbaldeston, of Blackburn, Lancaster, metal herald maker, for "improvements in looms for weaving."—Sealed February 15.

Alexander Rousseau, of the Strand, for "improvements in fire-arms," being a communication.—Sealed February 15.

George Haden, of Trowbridge, engineer, for "certain improvements in apparatus for warming and ventilating buildings."—Sealed February 15.

John Lewthwaite, of East Street, Manchester Square, engineer, for "improvements in steam engines and boilers."—Sealed February 15.

Thomas Russel Crampton, of Lisson Grove, Middlesex, engineer, and John Coope Hadden, of Moorgate Street, London, civil engineer, for "improvements in steam engines and railway carriages."—Sealed February 15.

Robert Worninn, of Stone Street, Bedford Square, piano-forte maker, for "improvements in the actions of piano-fortes."—Sealed February 15.

Daniel Greenfield the elder, of Birmingham, brass-founder, for "an improvement in the manufacture of hollow metal knobs for the handles of door and other locks."—Sealed February 21.

Moses Poole, of Lincoln's Inn, gent., for "improvements in treating, refining, and purifying oils, and other similarsubstances," being a communication.—Sealed February 21.

CANAL WORKS.

FIG. 1.

FIG. 2.

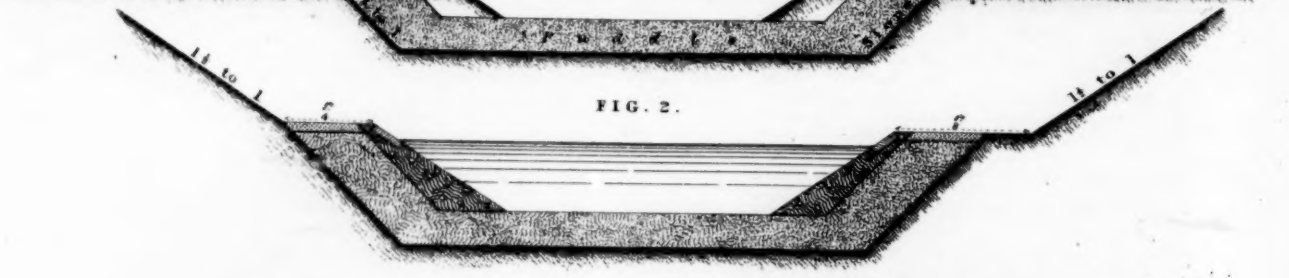


FIG. 3.

FIG. 4.

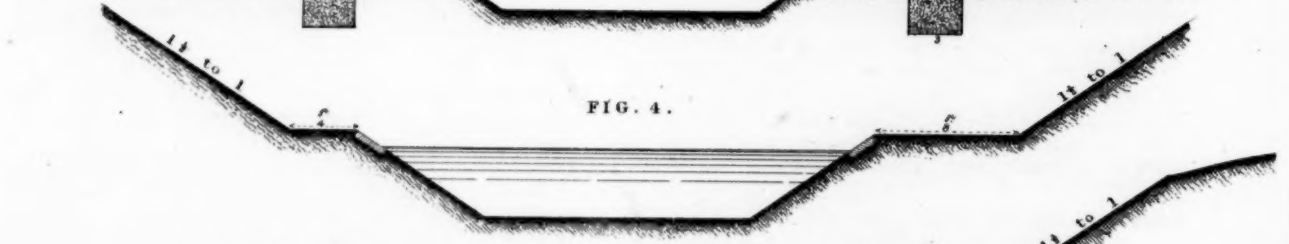


FIG. 5.

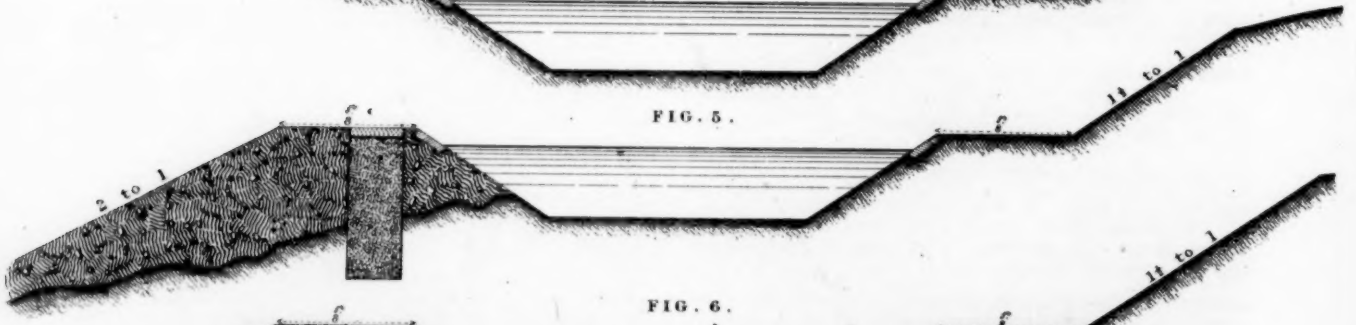


FIG. 6.

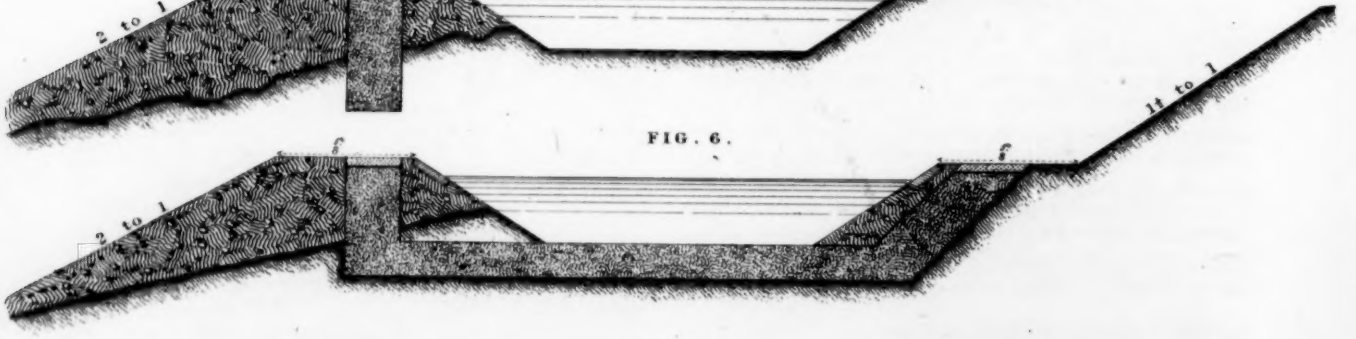
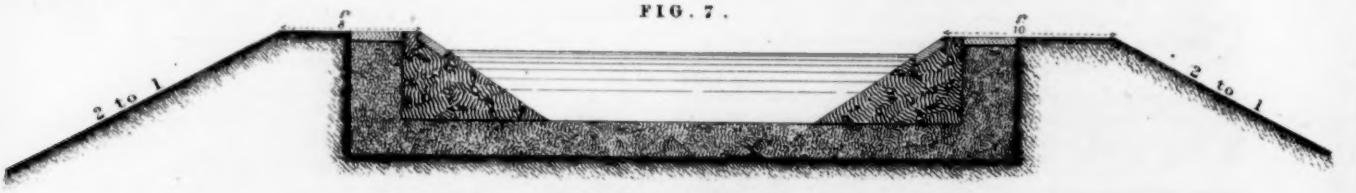
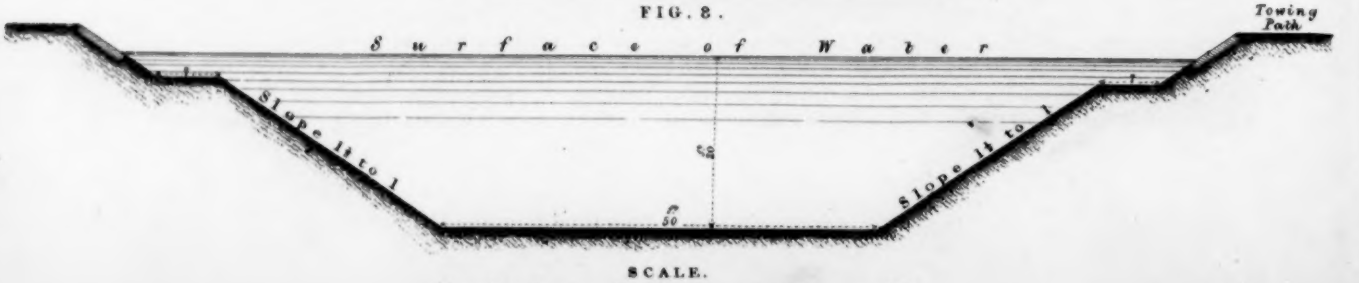


FIG. 7.



SCALE FROM FIG. 1. TO 7.

FIG. 8.



SCALE.

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